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PROF. ROBERT E. ROGERS.

PROFESSOR ROBERT EMPIE ROGERS, who retired but a few months ago from the chair of Chemistry in the Jefferson Medical College, died in Philadelphia, Sept. 6. He was the last survivor of four brothers, all of whom occupied foremost positions among the distinguished scientists of America.

Born in Baltimore, in 1813, Robert E. Rogers was graduated as an M.D. at the University of Pennsylvania in 1836, when he presented an experimental essay on Endosmose, which was deemed by the faculty of sufficient importance to be published as a contribution to knowledge. After serving as chemical assistant to his brother, Henry Darwin Rogers, in the first Geological Survey of Pennsylvania, he was chosen Professor of Chemistry of the University of Virginia, in 1844. This chair was occupied by Professor Rogers until 1852, when, on the death of his brother, Dr. James B. Rogers, he succeeded the latter as Professor of Chemistry in the Medical Department of the University of Pennsylvania. Professor Rogers served with distinction in this capacity for a quarter of a century, and for a considerable period in the mean time was the Dean of the Medical Faculty of the institution. He resigned in 1877, when he accepted the Professorship of Chemistry in the Jefferson Medical College. In July of the present year Professor Rogers vacated this chair in the hope that his somewhat impaired health would be recovered.

SCIATICA.

IN the *Amer. Pract.* Dr. Comingor of Indianapolis recommends a somewhat new adaptation of an old treatment. The patient is placed under chloroform or ether; the affected limb is thoroughly flexed and extended, and made to move freely in all directions, and then at once put up in plaster of Paris, in which it is allowed to remain for a week. At the end of this time the cure should be complete. The treatment is best adapted for severe cases with contraction of the limb. It is virtually nerve stretching without incision. With the forcible flexion we are already familiar, but not with the combination of a subsequent plaster case. We consider the method worth trying, and therefore record it.—*Edinburgh Med. Jour.*

THE TURIN EXHIBITION

THE Italian Exhibition at Turin, now in the glory of success, displays in a striking manner the rapid progress which Italy is making in the useful arts and manufactures.

The exhibit of Italian made agricultural implements is quite remarkable, and embraces the most improved patterns of plows, harvesters, reapers, agricultural engines, etc. The Italians are not now dependent upon England for this class of machinery, but make their own. The same may be said in respect to other mechanical branches of work. New inventions are appreciated and encouraged in Italy. Her patent laws are liberal, and patents are readily granted to Americans and other foreigners.

Our engraving gives a general view of the Exhibition buildings and grounds. Considering the taste and beauty of the surroundings, and the elegance of many of the buildings, the Turin Exhibition deserves a high rank among European enterprises of this nature.

The edifices and inclosed grounds cover an area of 340,000 square meters (about 84 acres), of which the buildings occupy an area of 143,000 square meters, and nearly equal to that occupied by the Paris International Exhibition of 1867, and three times that of the Milan Exhibition of 1881.

The principal range of buildings is 650 meters in length, and are built in line with the Corso Massimo d'Azeglio. To the east of this main gallery are others at right angles, which are united at the opposite end by others parallel to the principal one. These buildings are in various styles, and were designed by Signor Camillo Riccio, the architect to the Executive Commission.

The official general catalogue extends to a thousand pages, and the classification adopted shows the extent and scope of the Exhibition.

Thus we have the following divisions:

Division I. Fine Arts.—Section 1. History of Art. Section 2. Modern art (painting, sculpture, and architecture). Section 3. Music.

Division II. Education.—Section 4. School construction, instruments, and appliances. Section 5. Methods adopted for teaching literature and general knowledge. Section 6. Methods adopted for teaching the positive and experimental sciences. Section 7. Industrial and special instruction. Section 8. Books and libraries.

Division III. Scientific and Literary Publications.—Section 9. Documents and relics relating to the history of political events in Italy, from 1820 to 1870. Section 10. Scientific and literary publications.

Division IV. Public Welfare.—Section 11. Public welfare under a sanitary aspect. Section 12. Public welfare under an economic and moral aspect. Section 13. Public aid under a sanitary aspect. Section 14. Public aid under an economic and moral aspect.

Division V. Extractive and Chemical Industries.—Section 15. Quarries, mines, mineral and metallurgical industries, mineral waters, etc. Section 16. Chemical arts, chemical products, dyeing, tanning, etc.

Division VI.—Section 17. General mechanics. Section 18. Industrial mechanics. Section 19. The mechanics of locomotion and navigation. Section 20. Military and naval weapons and equipment. Section 21. Agricultural machinery. Section 22. Scientific instruments, which includes electricity.

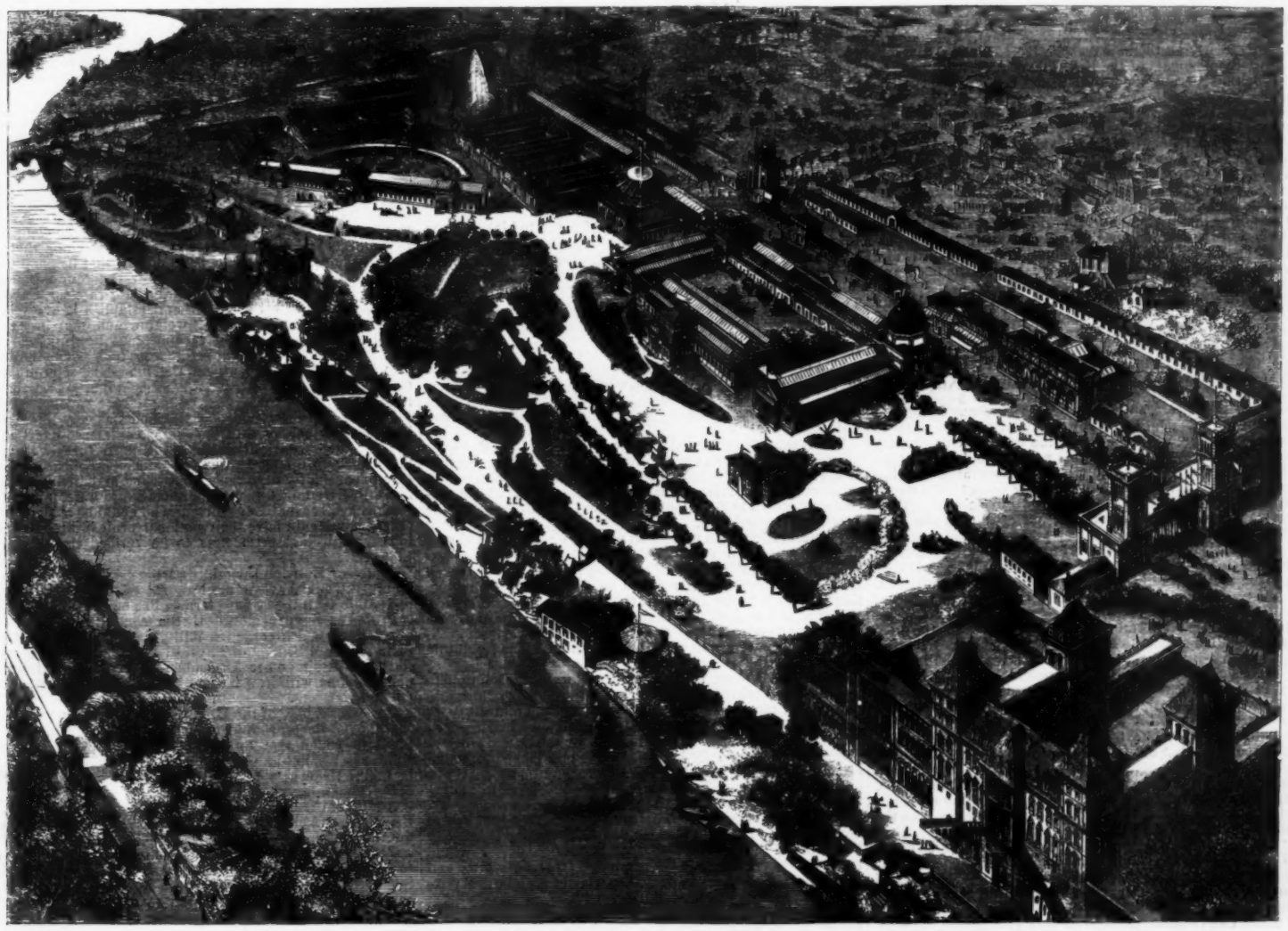
Division VII. Manufactures.—Section 23. Products of manufacture. Section 24. Gallery of labor (machinery in motion, and processes in operation).

Division VIII. Rural Economy, Horticulture, Forestry, etc.—Section 25. Agricultural industry. Section 26. Food. Section 27. Forestry. Section 28. Fishing and hunting, products of the animal kingdom, manures, etc. Section 29. Cattle, domestic animals, poultry, etc.

Each section is further subdivided into categories.

The total number of exhibitors, according to the official catalogue, is 12,776, distributed as follows:

Division	I.—Fine arts	1,579
"	II.—Education	1,194
"	III.—Scientific and literary works	191
"	IV.—Public welfare	2,054
"	V.—Extractive and chemical industries	989
"	VI.—Mechanical industries	936
"	VII.—Manufacturing industries	2,663
"	VIII.—Rural economy, horticulture, forestry	2,591
Special Exhibits: Astronomy, meteorology, exhibits of ministers of public works, ministers of agriculture, Alpine Club, City of Rome, City of Turin		579
		12,776



THE ITALIAN INDUSTRIAL EXHIBITION AT TURIN.

GRAND BICYCLE TOURNAMENT AT LEIPZIG.

The German, Austrian, and North German bicycle clubs met at Leipzig and united to form one society, known as the Society of German Wheelmen. The union of the several clubs was celebrated by a grand tournament on the 16th, 17th, 18th, and 19th of August.

On Sunday morning two hundred wheelmen paraded through the city in their elegant club uniforms; and in the afternoon they raced on their new race course, illustrated in the Scientific American Supplement, No. 448, of August 2, 1884. The great feature of the day was the race of 10,000 meters (6 miles 182 feet), for the championship of Germany and Austria, for which there were six starters, of whom J. Huber came in first in 19 m. 58⅘ s., and J. Schwartz second in 20 m. ⅗ s. Huber was awarded a gold medal worth 200 m., and Schwartz received the prize of honor of the Leipzig Club, consisting of a wine set ornamented with silver.

On Monday evening the fancy performances on the bicycles took place. They were opened by a "cavalier polonaise," followed by the performances of the youngest member of the club, shown in No. 4 of our illustration. "The Jolly Students," performed by the members of the Magdeburg Club, followed next. Then Messrs. Dorhmann and Alsen contested for the prize for fancy riding, consisting of a gold medal (see Nos. 6 and 11). "Puss in Boots" and "His Family" were next performed by the Magdeburg Club (see No. 12). The second part of the programme consisted of a quadrille and fancy riding, for which three prizes had been given by the Leipzig Club. First in order came the "Flag Quadrille" (Nos. 13 and 14), then a "Comic Intermezzo" (No. 15), and then the "Fancy Duet" (Nos. 16 and 17). "The Steel Horse and the Rose" concluded the performances.—*Illustrirte Zeitung.*

THE NATIONAL ELECTRICAL CONFERENCE.

The National Electrical Conference began its session in the lecture hall of the Electrical Exhibition, Philadelphia Sept. 8. Nearly all the new seats in the hall were occupied, many of the members of the British and American associations for the Advancement of Science being present. The meeting was called to order by Professor Simon Newcomb, who, in briefly announcing the objects of the conference, remarked that it was only in consequence of the reduction of electricity to mathematical laws that it had become possible to make it of such great practical use.

The President of the Conference, Professor H. A. Rowland, of Johns Hopkins University, read an elaborate review of the progress made in electrical science, especially during the last three hundred years. He said it was only after the invention of the Leyden jar that the idea of forming a current of electricity occurred to man. Two hundred and twenty years of study were necessary before the telegraph was possible.

"We are still but children, studying the A B C of electricity," he said. "Electricity cannot exist without matter. When we know what matter is we will know what electricity is and what magnetism is." He favored the adoption of international standards for the measurement of electricity.

"To-day," he continued, "our country, by its liberal patent laws, encourages applied science. We point to our inventions with pride, and our machinery in many of the arts is not surpassed. But in the cultivation of the pure sciences we are but children in the eyes of the world. Our country has now attained wealth, and this wealth should partly go in this direction. We have attained an honorable position in applied science, and now let us give back to the world what we have received in the shape of pure science. Thus shall we no longer be dependent, but shall earn our own science as well as inventions.

"Let physical laboratories arise; let men of genius be placed at their head, and best of all let them be encouraged to pursue their work by the sympathy of those around them. Let the professors be given a liberal salary, so that men of talent may be contented. Let technical schools also be founded, and let them train men to carry forward the great work of applied science. Let them not be machines to grind out graduates by the thousand, irrespective of quality, but let each one be trained in theoretical science, leaving most of his practical science to be learned afterward, avoiding, however, overtraining. Life is too short for one man to know everything; but it is not too short to know more than is taught in most of our technical schools. It is not telegraph operators, but electrical engineers, that the future demands."

Sir William Thomson, Vice-President of the Conference, made an address in which he said that one of the most important subjects to be taken up by the Conference was the foundation of a system of electrical measurements.

"We want instruments," he said, "that will be as quick and convenient as fish or sugar scales." He spoke of the self-sacrificing spirit of such scientists as Faraday and Henry, who devoted their time to scientific study, letting others profit by the application of their discoveries to practical use. The twofold purpose of this Conference, he said, was to promote the application of electrical science to the wants of man, and to enable the investigators assembled to get the benefit of one another's observations and experience.

THE ELECTRICAL EXHIBITION.—SECOND DAY'S PROCEEDINGS.

The second day's session of the Conference was held in the Annex of the Exhibition. The meeting was called to order by the President, Professor Rowland, who introduced Professor Cleveland Abbe, of the United States Signal Service, who delivered an interesting address on the

WORK OF THE UNITED STATES SIGNAL SERVICE IN RELATION TO EARTH CURRENTS AND ATMOSPHERIC ELECTRICITY.

He referred to the almost total neglect of the subject previous to the years 1880 and 1881. In those years it became necessary, he said, to train a special set of observers, who were to accompany the Greely expedition and make observations on the electrical and magnetic phenomena of the far north. Professors Trowbridge and Rowland, who were selected for this work, had afterward continued their instructions to other chosen members of the Signal Service Corps. It was hoped to gradually extend the number of stations where electrical phenomena might be properly observed, when the meeting of the International Conference of Electricians was held in Paris. At this conference the co-operation of the various governments in this very line of work was asked, and the resolutions transmitted to our State Department at Washington, and by them to the War Department, had come to the Signal Service as orders, and hence a series of questions had been prepared and transmitted to practical electrical engineers all over the country, in order that the extent of private co-operation with the government efforts might be known. Professor Abbe had also been instructed to draw the attention of this Conference to the questions. He moved that a committee be appointed to consider the questions, and with instructions to report to the United States Electrical Commission in three months' time.

After some discussion the motion was adopted.

The President then introduced Professor John Trowbridge, of Harvard College, who opened the discussion on the adoption of the

INTERNATIONAL ELECTRIC STANDARDS.

He read a letter from the Department of State to the Electrical Commission, inclosing the resolutions passed by the International Conference at Paris, asking the various Governments to legalize the measures of force as a standard in their several domains.

These resolutions fix the legal ohm as the resistance offered by a column of mercury of a cross section of one square millimeter and a length of one hundred and six centimeters at the temperature of melting water. The ampere is represented by one divided by ten in the C. G. S. system. The volt is the electromotive force which sustains the current of one ampere in a conductor whose resistance is equal to one ohm.

The next resolution is in reference to the gathering of statistics in relation to atmospheric and terrestrial electrical disturbance.

The final resolution fixes the unit of each simple light as the quantity of light of the same character emitted from a surface of one square centimeter of melting platinum at the temperature of solidification.

Professor Trowbridge submitted these resolutions to the Conference, suggesting that they be considered separately.

Professor Sir William Thomson as one of the Paris conferees, explained how the length of the standard ohm came to be established at 106 centimeters. He stated that it was his impression that a majority of the conferees believed that the actual length of the conductor should be more accurately 106·2 centimeters, but that as there was quite a difference of opinion, amounting to three or four millimeters, it was the opinion of the Conference that the measure should be fixed at 106, as the nearest whole number; and that when observations should be more extended, and the value of the ohm definitely fixed, the length could then be altered. In the mean time, he urged the adoption of the number 106 as the means of unifying scientific work. He asked Professor Rowland to give the Conference the results of his experimentation, which he had been conducting to determine the true length of the ohm.

Professor Rowland referred the Conference to his colleague Professor A. L. Kimball, of Baltimore, who gave these results as far as they had gone, as follows: One British Association ohm was equal to 0·9864 of the accurate ohm, and this figure must be within one three-thousandths of accuracy. The specific resistance of mercury was 0·9530 in British Association units, and hence the accurate ohm should be a column of mercury of one square millimeter in section and 106·278 centimeters in length.

The motion that the Commission be directed to take the proper steps to legalize the ohm, adopted at the Paris Conference, in this country was adopted. Similar motions with respect to the resolution regarding the volt and the ampere were also adopted.

The resolutions concerning the collection of statistics with regard to atmospheric electricity were, on motion, referred to the same committee to which the former resolution on the same subject was referred, with instructions to render a preliminary report to this Conference, and a final report to the Electrical Commission.

The resolution with respect to making a new standard unit of light was then considered. Professor Trowbridge explained Siemens' method of studying this unit, and moved that its consideration be referred to a committee with directions to report to the Electrical Commission. A conference, who was also one of the examiners of the exhibition, proposed an amendment that the committee be directed to render a preliminary report to this Conference. The resolution and amendment were adopted.

Mr. W. H. Preece, of London introduced a resolution to appoint a committee to consider the advisability of the substitution of the "watt" as a measure of dynamic force in the place of the foot-pound or the horse-power. He stated that the watt since its introduction by the late Professor Siemens had practically been adopted, but lacked any official conformation. At the Paris Conference the proposal was negatived, on account of the German opposition to adding more technical terms, and to the fact that there was no "w" in the French language. There are 746 watts in the present horse-power. It would cause but slight confusion to increase the nominal horse-power so that one horse-power would represent 1,000 watts. The resolution was agreed to, and this committee was also directed to render a preliminary report to the Conference.

On the third day, Sept. 10, the Conference assembled in the lecture room of the Franklin Institute. The Conference was called to order by Professor Rowland. The President announced the committees directed during yesterday's proceedings, as follows: On the question of the adoption of the unit of light and on the adoption of the "watt" as a unit of power—Professor Trowbridge, Chairman; Messrs. Preece, Cross, Edison, Pickering, Barker, and Heap. On the means of gathering statistics of atmospheric and terrestrial electrical disturbances—Professor Abbe, Chairman; Messrs. Allen, Trowbridge, Yates, Preece, Gisborn, and Nipher.

Professor M. B. Snyder, of the Philadelphia Central High School, then opened the discussion on the

ESTABLISHMENT OF A NATIONAL BUREAU OF PHYSICAL STANDARDS.

After some considerations of the necessity of the legal fixation of standards of a physical measurement, and some reference of the government work done by the Bureau of Weights and Measures and of the Coast Survey, he stated the requirements for a successful supervision of this important work. He said that the work must of necessity be a government work to give it sufficient means to determine the scientific questions, and to give force and authority to their determinations.

It would be necessary for the department to provide first for the very best and most scientifically accurate work, and second for furnishing the public with the practical results of that work. He did not think it should be connected with any of the present departments of the government, lest its work should be hampered in other directions. It should include both a laboratory and observatory as well as be a center for the deposition of standard weights, measures, and means of determining every form of power.

Professor W. A. Rogers, of Cambridge, said that there was undoubtedly a need for such an institution as Professor Snyder had suggested, but that it was a debatable question whether the ends would be reached best by founding a new department, enlarging the old bureaus, or depending upon private munificence independent of government control. He thought that the majority of the Conference would agree with him that, in order to gain proper authority, it was necessary that the institution should be under government control. Its functions, he thought, should be more limited than Professor Snyder had indicated, and should be restricted to the determination and control of units of power only, leaving the questions of dividing or multiplying and of making new standards to private enterprise and investigation.

Professor Hilgard, of the Coast and Geodetic Survey of the United States, did not agree with Professor Snyder as to the advisability of forming an entirely new department. He thought such an institution would paralyze individual enterprise, and be productive of no good result. He was of opinion that the great function of government was to maintain equity, and not to define the microscopic divisions of modern science. The United States was already a subscribing nation to the International Bureau of Weights and Measures, and this he believed was as far as the government should at present be asked to go. He mentioned incidentally that he had received intelligence the day before that Great Britain, after long holding out, had also joined the International Bureau. He also referred to the work of the Coast Survey, and stated that they had several times measured base lines of ten miles and over with a smaller error than one one-millionth.

Lieutenant Allen, of the Signal Service, presented some of the work of the Signal Service Bureau, of the War Department, in the way of accurate measurement of heat and the pressure of the air. He presented no opinion as to the advisability of a new department of the government, but merely some of the scientific work done in his own department. He believed that fixed standards, especially of electrical units, were a great desideratum.

Professor Simon Newcomb thoroughly believed in the necessity of the formation of such a department. He pointed out the authoritative character of the government stamp, and believed that an action had been taken during the closing hours of the last Congress looking to the consolidation of several of the scientific bureaus, that the present was a most favorable time to urge the formation of the department.

Sir William Thomson believed that the United States would find it absolutely necessary to have a bureau of standards much more extensive than that which it now possessed. He called attention to the good work done in England in thermometric observations by the Kew Commission. He was sure that both governments would soon be compelled to found complete bureaus, and he was anxious that the United States bureau might be founded, that its good work might serve as another argument for the foundation of a British Bureau. Instead of restricting Professor Snyder's idea, he would rather expand it and establish in every large city an official inspector of weights and measures. He thought that the success of incandescent lighting was now assured; that it was certain before long to become the ordinary house to house system, and that hence the determination of the legal volt-ampere would be as important as that of the meter or the yard.

Mr. W. H. Preece said that England was very like America in the general desire of the average citizen to be let alone by legislative restrictions, until the need for government interference is distinctly felt. It was, consequently, necessary to constantly urge the government action in questions like this. He hoped that the United States bureau might be established, because Englishmen, who could be reached in no other way, would have their national pride injured by sending of English amperemeters to be verified in the United States.

Professor Houston thought that the establishment of such a bureau would have a most useful effect in familiarizing the public with the strange terms of electric measurement.

Professor Snyder moved that a committee of seven be appointed to consider the feasibility and manner of establishing a National Bureau of Physical Standards, and report to the Commission before December 1. After some informal discussion he withdrew his motion to allow of further discussion.

Professor Abbe, of the U. S. Signal Service, was anxious that the barometer should especially be examined. Mr. N. S. Keith stated that unless the measures of electric force were soon legalized a most complicated question would soon be before the courts to determine in the case of legal difficulty concerning electric lighting.

Additional remarks were made by Professors Wead, J. K. Trowbridge, Abbe, Meyer, Rogers, and Mr. Silvanus Thompson, of England.

Prof. Abbe moved that the Conference approve of the formation of a National and International Bureau of Physical Standards. Prof. Rogers proposed as an amendment that a committee of three be appointed to draw up a resolution which should express, if possible, the opinion of the Conference. After considerable discussion the amended motion was carried, and after another motion had been adopted adding Prof. Rowland's name to the committee the chairman named as the committee Professors Rogers, Newcomb, and Wead.

THE COMMITTEE ON THE ADVISABILITY OF THE FORMATION OF A NEW UNIT OF POWER REPORTED VERBALLY THROUGH MR. W. H. PREECE.

Fourth day, Sept. 11. Same place.

The report called attention the great necessity of some unit of power in accord with the metric system and with electrical engineering. This necessity the watt, in the opinion of the committee, met perfectly. A watt defined electrically was the rate at which work is done when a current of one ampere is maintained in a resistance of one ohm. It has, therefore, been called the volt-ampere, but this name was awkward, and the name of watt, himself the first careful measurer of power, was fitly appropriated to it by Professor Siemens. The unit of power which Watt adopted was the horse-power. By a series of experiments he determined the work of one horse to be about equivalent to that of raising 22,000 pounds one foot every minute. This number seeming too small to him, he added fifty per cent., and arbitrarily fixed the horse-power at 33,000 foot-pounds. As the watt is too small a measure to be suitable for large measurement, he proposed that the arbitrary horse-power be raised 34 per cent., so that instead of representing 33,000 it would be about 44,000 foot-pounds. It would then be equivalent to exactly one thousand watts. He therefore moved that it is the opinion of the Conference that the unit of power should hereafter be the watt, and that the value of the horse-power should be raised so that it should equal

one thousand watts. After a little discussion the motion was adopted.

The Committee on the Advisability of the Formation of a Bureau of Physical Standards made a report, which after considerable debate was referred back to the Committee for amendment.

The Committee on the Standard Unit for Light reported informally through its chairman, Professor Trowbridge, that in the opinion of the Committee the standard unit of light proposed by the Paris Conference was impracticable, and that they did not believe its adoption advisable in this country. He called upon one of his colleagues, Mr. Preece, who had prepared some statements.

[The standard unit of light here referred to is that amount of light of the same character as the light to be examined which is emitted from the surface of one square centimeter of melted platinum at the temperature of solidification.]

Mr. Preece said that he had devoted much time to the study of the measurement of light as a member of a committee of the British Association. Two points are necessary to be considered. First, the formation of a practical standard for all lights; and second, the accurate definition of the standard of white light. The first of these is practically all that is necessary to examine. After referring to the personal equation of the individual observer, he went on to consider the systems which are legal in the various countries. In England they have a standard sperm candle of certain quality and burning 120 grammes per hour. In Germany they have a different standard candle. In France they use a lamp known as the Carcel, which represents about 9·7 of the British standard candle power. Mr. Preece believed that all of these were defective, because they did not relate to the illuminating power, the important point of the light. He had proposed as a standard the light given off from a perfectly white surface when the light from a British standard candle fell upon it from a distance of 12·7 inches. This would correspond to the amount of light given off when the same surface was illuminated by a Carcel lamp at the distance of one meter. He thought the practical method of comparing and studying the three points, the standard of light, the standard of illumination, and the means of photometric measurements, were best found in the incandescent electric lamp. It was convenient and accurate, and could always be reproduced. He promised further aid to the Committee until their report to the Commission should be rendered.

Professor Koyle asked if the surface of incandescent platinum of a certain size would not be better than that of the carbon filament. Mr. Preece replied that in the air the surface of platinum had not been successful, and that sufficient experiments had not been conducted with platinum *in vacuo*.

Professor Henry A. Rowland, of the Johns Hopkins University, then opened the discussion on

THE THEORY OF THE DYNAMO ELECTRIC MACHINE.

He stated that neither time nor opportunity offered for more than a general inquiry into some of the theoretical considerations affecting dynamos. One of the first and most important considerations was that of the causes of loss of power. These he divided into five—mechanical friction, Foucault currents, the current used in sustaining the magnet, the heating effects on the revolving coil, and the production of self-induction in the coil.

The first two of these needed no discussion. Their remedies were obvious, and had already been applied. Under the third cause the speaker suggested several possible causes of loss of power, such as the use of wrought iron instead of steel in the magnets, the elongated shape of the cross section of the magnets in some of the forms, and especially on the duplication and multiplication of magnets. The form of the poles of the magnets was also a possible cause of loss of energy. He showed how in several forms of the machine leakage of magnetic force would occur. His deductions were that the magnets of a perfect dynamo must be circular in section, of one pair of poles, and perhaps of steel; that the poles should be of large size, approaching closely to the armature, and that opportunities of leakage should be avoided as much as possible. He believed, with reference to the fourth cause of loss of power, that more was lost than was generally understood.

In the Gramme ring he thought that as much as one-half the electric energy was wasted in what was called "dead" wire. In the Siemens armature the loss, while not so great, was yet probably very considerable. In the same way the distance which separated the poles of the magnet from the armature was "dead." The fifth cause he would leave to be discussed by Professor Fitzgerald.

The speaker then proceeded to elucidate by formulæ the strength of the magnetic field the force necessary to expend in magnetization, the weight, and, finally, the efficiency and speed of a theoretically perfect dynamo machine of any given size. His results show that leaving out of the question various minor mechanical considerations, size had nothing to do with efficacy. The increase of efficiency he showed must be due to the greater proportional speed of the armature, and to other considerations.

Professor Francis J. Fitzgerald, of Dublin, Ireland, considered the loss in the dynamo machine from the induction of local currents in the coils. He showed how the sudden reversal of the direction of the current occurred under the brushes of the machine, and how in faulty construction of these brush contacts short circuiting and loss occurred. He agreed with what Professor Rowland had stated, but criticised the statement that the efficiency did not depend on the increase of size, pointing out that several causes of internal resistance, notably in the loss from separation of the armature from the poles of the magnet, did not increase with the increase in the size of the machine.

Professor Elihu Thomson criticised the paper of Professor Rowland in many points. He did not believe that extension of the poles of the magnet would be followed by a gain, since loss by radiation into the air would be inevitable. Neither did he see the objection to having a double magnet with the poles joined and the armature in the center. He thought that the loss would be far less than where the poles were placed upon and within a few inches of an iron base plate, and with the armature revolving on the internal lateral surface of the poles. As to the use of steel he had made extensive practical experiments, and had found nothing which was so suitable as was soft malleable iron. In the matter of the "dead" wire of the Gramme ring as represented by Professor Fitzgerald, he thought that the "loss" was based on a mistaken theory, and that there was no "dead" wire, save possibly at the moment of changing the direction of currents; certainly the statement that fully one-half the wire was dead was incorrect. He also criticised Professor Fitzgerald's statements as to the internal self-induced currents of the armature.

Professor Rowland took the floor to reply to Mr. Thomson's remarks. He claimed that he was correct in stating that steel could be as easily magnetized as iron, and that his experiments in previous years had proved the fact. He reiterated his views with regard to the proper form of magnets and poles.

Professor Rowland attacked this statement, which, he said, was evidently a mistake, and that, if true, it would strike at the foundation of all the acknowledged laws of magnetism.

Mr. Thompson replied that he had performed experiments which proved the fact.

Professor Forbes made an explanation reconciling the discordant results. The discussion became general on the methods and time required to saturate masses of iron, and the advantages and disadvantages of a slow or quick magnetization of the field magnet.

Professor Newcomb introduced the report of the Committee to consider the Advisability of establishing a

BUREAU OF PHYSICAL STANDARDS.

The resolutions as agreed upon were as follows:

Whereas, The rapid increase in the applications of electricity require the adoption and legalization of common standards of electrical measures to form the basis of contracts for the supply of electricity; and

Whereas, The realization of such standards requires that all instruments for electrical measurements shall be tested and verified by one central authority; therefore, be it

Resolved, That this Conference deem it of importance that Congress, in pursuance of its constitutional authority to fix a standard of weights and measures, should fix a standard of electrical measures, and in order to secure the use of such standards should establish a bureau charged with the duty of examining and verifying instruments for electrical and other physical measurements.

Resolved, That the President of this Conference be requested to communicate the above resolution to Congress through the proper official channels.

Resolved, That the United States Electrical Commission conducting this Conference shall appoint a suitable commit-

THE GRAND BICYCLE TOURNAMENT AT LEIPZIG.

tee to represent this Conference before Congress, and to move for such legislation as will secure the object of these resolutions.

The Conference assembled on the fifth day, Sept. 12, in the hall of the Franklin Institute, and was called to order by Professor Rowland. The president made a few remarks on the debate of yesterday, and the value of theoretical work in electric engineering. In pursuance of the order of the day, he called upon Professor F. E. Nipher, of St. Louis, to open the discussion on the

ELECTRICAL TRANSMISSION OF ENERGY.

Professor Nipher stated that he had been engaged for several months in attempting to represent graphically the energy transmitted by a dynamo generator, and converted back to power by a motor. He hoped from these to determine constants of a particular form of machine which could afterward be used as a standard of comparison with other machines.

Professor Edwin J. Houston believed that a standard of the transmission of energy could perhaps be best studied by the amount of light which that energy was capable of producing.

Mr. Sprague did not agree that dynamic energy could be studied by the amount of light produced. He thought the study of electrical transmission of power had never been properly made, and that it would be found that for practical effectiveness it would be necessary to use currents of very much higher potential than had previously been used.

STORAGE BATTERIES.

The discussion on storage batteries was opened by Mr. W. H. Preece, the chief of the postal telegraph system of Great Britain. Mr. Preece began by saying that Mr. Edison had said not long ago that as soon as a man commenced to talk of storage batteries he commenced to lie about them. Mr. Preece said that this was true a little while ago, but that they had now fallen into disgrace deeper than he believed they deserved. He preferred the term secondary battery to that of storage battery.

In telegraphy he believed that the storage batteries had a great future. In America the Western Union Telegraph Company had adapted dynamos to the uses of telegraphy. In England it was impossible to do this, because they did not work with closed circuits. In the English method of telegraphing it was necessary that the current should be absolutely steady, but the current of a dynamo was not steady for an instant. But when the dynamo is used to charge a secondary battery, the current may be drawn off absolutely steady.

In his own house he had experimented, or rather had established them as a means of supplying electricity for lighting. He explained that he lived far away from any source of electricity, and consequently his house was lighted by gas. He preferred, however, to burn his gas in the garden, to avoid the poisonous products of combustion, and merely use it as a means of power for running a dynamo-electric machine. His gas engine was of two horse-power, and ran a Gramme dynamo of forty-two volts and supplying fifty-two amperes. The dynamo running three hours each day under the care of a servant charged seventeen Plante cells, each containing twelve plates about two feet square. This arrangement has run for about four months without the sign of failure, and lights his house perfectly with incandescent lights, besides being used lavishly for other purposes.

Storage batteries were also used for the lighting of trains by electricity, the batteries being charged by dynamos connected with the running gear of the trains. Of these he had no experience, but believed they were still used on some of the English railways.

The defects of the storage batteries were numerous and serious. The lead plates buckle and short circuit unless screens of ebonite, or wood and paraffine, are interposed. After four months' experience some of his plates were showing signs of disintegration, but he thought that the life of the battery would be at least one, perhaps two years' constant use. In his own batteries he was only able to recover about forty per cent. of the original energy.

Professor Carhart thought that the original cell of Plante was better than any of the modifications. He had seen it stated that the best Argand gas burner only utilized one per cent. of the energy of combustion in the production of light. If this were true, it would be far preferable to use the gas as a means of power.

Mr. Keith said that Plante was undoubtedly an inventor far in advance of his time, and he believed that storage batteries were destined to play an important part in the electricity of the future.

Mr. Charles H. Koyle reviewed the chemical questions involved in the storage battery. He believed that the proper method of procuring the plates was by the use of carbon as a base.

Mr. Frank J. Sprague further elucidated the steadiness of the light produced from a dynamo machine run by a gas engine when a storage battery was included in the circuit.

Mr. George Forbes reviewed the same subject by means of formulæ. He stated some of the causes of failure of storage batteries, and asked for statistics as to the life of the batteries.

Professor F. C. Van Dyck said that he looked for some reference to other secondary batteries, such as the one composed of zinc and copper in an alkaline solution. He had experimented very successfully with this battery.

Professor Elihu Thompson stated that the action of the battery in setting free oxygen would tend to disintegrate the plates, whether of lead or of carbon. He asked how carbon, which by intense heat had been changed into the graphitic variety, would resist disintegration. He had used another form of storage battery, composed of two plates of copper immersed in a solution of zinc sulphate.

Lieutenant Jewell called attention to the inequality of the current emitted from apparently perfectly similar cells of a storage battery, and described the method adopted for restoring the lost power of a cell. He had used storage batteries extensively, but was by no means satisfied with them.

Mr. Preece, in reply to the various remarks, said that the loss of energy in other forms of lighting was enormous when compared with electricity. A British sperm candle used up the energy of 96 watts; a gas burner, 62 watts per candle-power; a good incandescent lamp, only 2·5 watts; and an arc light only 1 watt per candle-power. These figures were remarkable from another point of view, since he thought that they indicated that the incandescent lighting was so improved as to reduce the power required to one watt per candle; as seemed probable, the days of arc lighting would be numbered. As to the use of carbon as plates, he did not believe that any method of manufacture would prevent disintegration.

Professor Dewar, of the University of Cambridge, England, then explained the chemistry of the secondary battery. He looked for some other substance than the suboxide of lead, since the problem was simply to discover some substance which could be decomposed by electricity and in its recomposition would give off electrical energy. He gave several chemical examples of substances which decomposed under electrical action into others which had a strong tendency to reunite, and desired further experimentation with such salts as permanganates, iodates, and chromates.

The committee on

ATMOSPHERIC ELECTRICITY

made a preliminary report as follows:

The committee recommend to the National Conference and to the United States Eectrical Commission that the government be urged to take steps to secure on a large scale observations of atmospheric electricity and the strength of earth currents.

That the methods of observation and reports conform as far as possible with those about to be disseminated by the International Bureau of Telegraphic Administration at Berne.

That the government appoint a permanent committee of five electricians to co-operate with the Chief Signal Officer of the Army in organizing this service.

That this committee shall include, among others, the electricians of prominent companies, such as the Western Union Telegraph and the Bell Telephone Companies, and others of wide experience.

The report was accepted, and action deferred.

Lieutenant Jewell, in reply to Professor Preece, stated that he was unable to observe any impurity in his lead plates, and believed that his loss of power was due to defective conduction due to the formation of a film, perhaps of sulphate of lead, upon the plates.

UNDERGROUND WIRES.

After some further discussion on the storage batteries, Mr. Lockwood, electrician to the Bell Telephone Company, opened the discussion on induction and other causes of disturbance in telephone wire, and the use of underground conduction. He said that it was generally agreed that the principal causes of the abnormal sound heard in telephones were not from induction, although that occasionally occurred. He classified the sounds heard in the telephone, and the principal causes which appeared to influence their formation. Long currents were much more liable to them than short ones, and occasionally a long wire will be noisy at one end and quiet at the other. North and south lines are also more affected than those east and west. The sounds are worse at midday and midnight. Near the seacoast the lines are usually quiet, while on high land lines are subject to storms of sounds. Lines composed of large wires are worse than when smaller wires are used, and those of iron worse than those of copper. Finally, lines of low insulation are better than those in which insulation is perfect. The delicacy of the electric currents prevents any improvement being found in altering the receiver, and the only remedy is in improving the conduction of the wire and in the force of the transmitter. All these facts point to the principal causes of these sounds to be terrestrial and atmospheric currents of electricity. Isolated noises are probably due to defective connections and contacts, and occasionally true inductive currents are produced by the contacts or juxtaposition of other telegraph or telephone wires. He rapidly reviewed the various remedies which have been proposed, including closed metallic circuits, the wires run parallel to each other, allowing a certain amount of leakage to the earth, the use of very good conductors and perfect connections.

With respect to underground telephoning he admitted that it was possible to use the underground system on circuits of limited extent, say eight to ten miles, but stated that the power of the telephone was so weakened that longer distances were impracticable.

Mr. Preece stated that the telephone is by no means so extensively used in England as in this country, but he believed that they were ahead of us in overcoming the difficulties stated by Mr. Lockwood. He agreed with him that the principal cause of trouble is due to terrestrial electricity, and was not from induction from other wires. In England the method used to overcome this effect was to use a metallic circuit, so arranged that the wires should revolve about one another at a distance of about six inches, making one turn at every four poles. By this means the induced currents were made to correct one another. He represented another method of using a double wire when each subscriber was supplied with but one wire.

In England all wires in cities are laid under ground, generally four in a cable, and no difficulty was experienced. A cable ran from Liverpool to Manchester, through which conversation was good. In Newcastle, where all wires are under ground, disturbance sounds were unknown. He admitted, however, that the sound was diminished, so that circuits of over twelve miles could not be satisfactorily worked.

After some further remarks, Mr. Lockwood, in reply, said that the system of twisting the wires had not succeeded in his hands, as it was said to have done in England.

SIXTH DAY'S PROCEEDINGS AND FINAL ADJOURNMENT.

The Conference held its final meeting on Saturday, Sept. 13, the president, Professor Rowland, in the chair. After the reading of the minutes the president called for action on the report of the Committee on Atmospheric Electricity, and after some debate it was adopted. Some discussion was held on the report of the Committee on the Unit of Power, in which little that was new was developed except as to the name to be given to the thousand watts. The "metric horse power," the "benry," and the "kilowatt" were proposed as suitable names. No definite action was taken. A resolution introduced by Professor Newcomb, asking the Committee on Unit of Light to report a system for the proper examination of the power of electric lights, was adopted.

FATIGUE OF METALS.

Captain O. E. Michaelis, of the Frankford Arsenal, then read a paper on "Electrical Investigation of the Physical Qualities of Structural Metals." He stated that the subject was hardly fairly stated, since he desired to ask questions and not to state propositions. In the course of his duties he had found that in making a number of cartridge shells, for example, of a composition metal of definite proportions, some of the finished cartridge shells would be found defective in tensile strength, although all the metal had been treated apparently to the same processes. This fact, which had often been noted, had been unscientifically called "fatigue" of metals. Its cause was unknown, although it was believed to be due to some molecular change caused by the metal being "broken down" in the heavy rolls during the process of formation of the shells. They possessed no means save that of actual experience of determining when a certain specimen of metal had undergone this change. He had discussed the subject with Professor George Barker, who had agreed with him that it was possible that this change might be determined by some electrical test. If such a means could be procured, he thought that the instrument which determined it would become the divining rod of the engineer, and it was to obtain the views of practical electricians that he had brought the subject forward.

Mr. Charles H. Coyle had experimented on the subject of fatigue in metals, and had found that alloys of every sort are more liable to this fatigue than homogeneous metals. He believed it to be due to some change probably in the ultimate molecules of such alloys, due to a difference of the electro-conductivity of the two metals. In some alloys, known as "deoxidized," and other bronzes, a change had been made in the size of the molecular pores which much increased their tensile strength. Such treatment altered the electro-conductivity of these metals, and hence he hoped that some method, such as Captain Michaelis had indicated, might be discovered.

MEASURING LARGE CURRENTS.

Mr. N. S. Keith, in opening the discussion as to the movements of large currents, said that he also desired rather to ask questions than to answer them. He was compelled to use an exceedingly large current so as to deposit each hour by electro-metallurgy 59 grains of lead, the most difficult of metals to deposit. He desired to use this quantity as a constant, and had trouble in using the ordinary electrometer except at a distance from the conducting wire. This conductor was of a diameter of $1\frac{1}{4}$ inches. What he desired to know was whether in measuring the distance of his galvanometer he must measure from the geometrical center of the conductor or from the circumference.

Mr. George Forbes replied that by using a very delicate galvanometer at a long distance the diameter of the wire might be disregarded for all practical purposes. Another method he suggested was by measuring the difference of potential at different points by the voltmeter, varying his conductor and correcting the results. In case it was necessary to measure as Mr. Keith had represented, it would be necessary to integrade the whole cross section of the conductor. He stated still another method, which was by means of the rotation of the plane of polarization in bisulphide of carbon, or of heavy glass. This could be measured within four minutes of a degree.

Professor Rowland pointed out that in the case of a cylindrical conductor integration of the cross section would lead to exactly the same result as measurement from the geometrical center. He believed that that the only proper instrument to use was an electro-dynamometer if it could be procured. It was certainly far preferable to the tangent galvanometer or the polarization method.

THE ELECTRIC LIGHT AT SEA.

Lieutenant-Commander Jewell, of the U. S. navy, read a paper on the "Applications of Electric Light to Naval Purposes." He said that the two uses of electric lighting at sea were as search lights, for which the most powerful arc lights were required, and for the internal illumination of the ship. Both of these are absolutely necessary for a modern vessel of war to be effective. At present such of the ships as are fitted up with these two systems carry three dynamo machines, each with its engine. Two of these are used for the arc lights, and give two lights of about 20,000 candles. They are arranged so that all the power may be turned into one lamp, in which case the power of the light is considerably more than doubled. The third machine supplies the incandescent lamps, which he regarded as a modern necessity. He desired to make the wants of the navy known, that makers might be able to supply them without appealing to France, as is now the case. He thought that two or possibly one dynamo could be substituted for the three. It should be a compound wound dynamo, giving a current of from 100 to 175 amperes, with an electromotive force of 60 volts. It must be driven directly without the intervention of belts on account of space. He thought such a dynamo would be capable of supplying an arc light of 20,000 to 25,000 candles, and of running 250 incandescent lamps. As to the projector, he did not think much improvement could be made on the model of the French projector in present use. He pointed out that though the government would need but few of these outfits, they would be equally desirable in ocean, inland, and coastwise merchantmen.

LIGHTNING RODS.

Professor Rowland opened the discussion on Lightning Protectors by describing the Maxwell system. This differs from the ordinary system in not attempting to dissipate the bolt, but by conducting it freely to the earth to prevent damage to the building. It consists in completely inclosing the building in a network of rods united together and united in the earth beneath the building. In case the lightning strikes a building so protected, it finds a ready means of conduction around the house without touching the interior. It is not necessary to insulate such a system of rods. He spoke of the very vague ideas of the average lightning rod man, and described a very dangerous system now in use, whose designer had arrested a scientific gentleman for slander, because he had denounced it as a humbug. Professor Rowland, while not anxious for a prosecution, had no hesitation in stating that it was a humbug, and a most dangerous humbug.

Mr. Scott asked if the iron sides of a petroleum tank did not form such a protector as the Maxwell system required.

Mr. W. W. Griscom described a petroleum tank, and showed the reason why they are particularly liable to lightning strokes.

Professor Houston added to what Professor Rowland had stated of the general ignorance of the subject of lightning protectors. In relation to the generally adopted system of pointed rods, suggested by Franklin, he repeated the conclusions reached by the Committee of the Convention of Lightning Protection Companies in London. That committee decided that rods were useless unless they contained the conducting power of a pure copper rod of 6 ounces to the running foot, and that they depended on mass and not on the surface exposed. The rod should be most thoroughly grounded, all connections soldered, and it was unnecessary to insulate it from the building. The points should be durable and not too slight, as delicate points are liable to fusion, and consequent firing of the building.

As to the space which a lightning rod would protect, he stated that it was generally considered to be a cone, of which the apex was the point of the rod and the radius of the base 1·75 times the height of the rod. As rods were generally constructed he believed them to be an absolute source of danger instead of a protection to a building, but that by follow-

ing the simple rules indicated they would efficiently protect from harm.

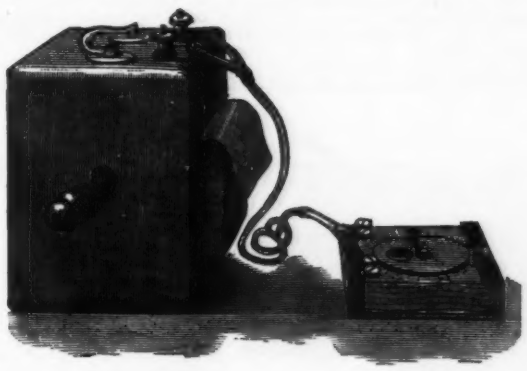
The hour of adjournment having been reached, Professor Gibbs presented a resolution thanking the managers of the Electrical Exhibition for their kindness to the Conference. Professor A. Graham Bell offered another resolution thanking the foreign conferees for their interest and assistance. Captain Michaelis desired also to thank the Franklin Institute and the officers of the Conference. The resolutions were adopted.

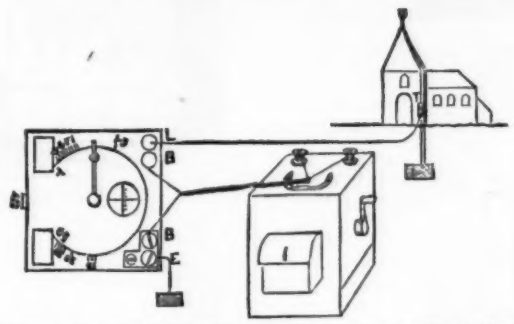
Mr. Preece, on behalf of the foreign conferees, desired to return his thanks for the uniform kindness and many courtesies which they had received. He hoped that the outgrowth would be the formation of a society which should meet at frequent intervals to exchange information which could be obtained in no other way, and hoped that he could again be present at meetings such as the present one had been.

After some discussion relative to another meeting of the Conference at some future time, the Conference adjourned to meet at the call of the chairman.—*Phil. Ledger.*

APPARATUS FOR TESTING THE RESISTANCE OF LIGHTNING RODS.

THIS apparatus, constructed by Messrs. Siemens Bros., consists of a magneto-inductor contained in a wooden box, and a small bridge board sliding into a recess at the bottom of the box. To the latter are affixed a German silver ring, a





APPARATUS FOR TESTING THE RESISTANCE OF LIGHTNING RODS.

pointer, which also acts as a battery key, a small galvanometer, four terminals, marked L, B, B, E, and beneath the board a constant resistance. The weight of the apparatus is 8½ pounds. It is advisable, when erecting a lightning rod, that a loose copper wire be connected to the point of same, running down parallel with it to the base. A connection may then be made to this, which would save the trouble of climbing up to the point each time the lightning rod had to be tested.

For economy's sake, when erecting a lightning rod two ropes, having the same sectional area as the single rope intended to be fitted, might be used, both of them being connected to the earth plate and acting as a single conductor. One of the ropes could then have a connection screw fitted at the base, T, so that it could be disconnected from earth for testing as required.

When a lightning rod is to be tested, terminal L has to be connected to the point of the rod or the loose wire below; terminal E to a reliable earth, and terminals B B to the inductor. Then, by turning the inductor handle and pressing down the pointer on the board, a current is sent through the bridge, and if a deflection be shown on the galvanometer, the pointer (being still pressed down) must be turned to the left or right until the needle stands at zero. The graduations round the ring have been so arranged, that in this position the pointer will stand at the figure corresponding to the resistance in ohms of the lightning rod and its earth connection.—*Elec. Review.*

BALL LIGHTNING.

By GASTON PLANTÉ.

A FEW years ago I described, under the name of the "ambulatory electric spark," a peculiar phenomenon produced by the passage of an electric current of high tension. If we put a thin mica condenser in communication, through its two armatures, with the electrodes of a secondary battery of 800 couples, the condenser may be pierced by reason of the high tension of the current; and as under such circumstances the quantity is much greater than with a source of static electricity, the effect is not limited to the production of a sound-producing spark, but there forms a small incandescent globule in consequence of the fusion of the material of the condenser, and this globule moves slowly over its surface, following in doing so the points at which the insulating sheet that separates the armatures presents the least resistance, and describing the most varied sinuosities (Fig. 1).

The experiment may last for one or two minutes, and only ceases when the battery has become discharged to such a degree that the globule can no longer keep melted between the two armatures.

The slow motion of this little globule is accompanied with a rustling sound, and, when the condenser is made adherent to the surface of a plate of hard rubber, there is heard a sharp and stridulous cry like that produced by a sheet of metal that is being sawed or torn by a toothed wheel revolving at high speed. The condenser is at the same time sawed and cut open throughout the whole extent of the globule's travel. I have already pointed out the analogy of these effects with those of ball lightning. In order to still better imitate the conditions under which the natural phenomenon occurs, I recently increased the tension of the source of dynamic electricity, and put in play a current from a battery of 1,600 couplers whose electromotive force at the first moments of the discharge was about 4,000 volts. On another hand, suppressing the sheet of mica and the metallic armature, since in the atmosphere there are only masses of air and aqueous vapor, I operated simply with humid, electrified surfaces that were separated by a stratum of air. These surfaces consisted of wads or disks of filtering paper moistened with distilled water (Fig. 2).

As soon as this arrangement is connected with the poles of a battery there will be seen to appear a small ball of fire, which will run from one side to the other between the two surfaces, and successively appear and disappear for several minutes. As the battery becomes thus discharged less quickly than it does between the metallic armatures, the phenomenon also lasts longer. The intermittent appearances are due to the fact that when the globule of fire has dried several points of the wet surfaces, through the caloric effect that it produces, and has caused the disappearance of the aqueous vapor whose presence diminished the resistance of the space between the surfaces, the current is interrupted at such points. But the effect then reappears at the other points that remain moist, and so on.

These experiments seem to me to confirm the explanations that I have already presented in regard to ball lightning, and I believe that I can now draw the conclusion therefrom with more certainty, that this kind of lightning is a slow and partial discharge, say a direct one, through induction, from the

FIGS. 1 AND 2.—EXPERIMENT UPON ELECTRICITY IN A GLOBULAR STATE.

electricity of the storm cloud when such electricity is in exceptionally large quantity, and the cloud itself, or the column of strongly electrified damp air which forms its electrode, so to speak, reaches the earth or is separated therefrom by a thin stratum of insulating air. Under such circumstances the electric flux, as a consequence of its abundance, or, more accurately, the ponderable matter that it is traversing, becomes aggregated as in the experiments just described, under the form of a ball of fire. It is, after a manner, a sort of electric egg, without glass envelope, that forms with the rarefied and incandescent elements of the air and aqueous vapor. This fulminating ball does not constitute a sort of bomb charged with electricity; and it is not fulminating and dangerous of itself, as is proved by the curious relation of Bobinet and other observers, since the least current of air suffices to move it. But its presence is nevertheless to be dreaded, since it leads electricity from the storm cloud with which it communicates in a latent or sometimes visible manner (as at the extremity of tromps), and reveals the place that it has selected for its floor. If the stratum of air that separates the cloud from the earth is not pierced, the ball of fire may disappear without noise, as has often been observed, or, if a portion of the storm cloud descends toward the earth at another point, the lightning may strike further off at the same time that the ball disappears. But, if the stratum of air is pierced, there naturally results at the very point where the ball appears a stroke of lightning accompanied with thunder, derived, not from the feeble quantity of electricity contained in the small mass of rarefied and luminous air that forms the ball, but from a sudden discharge of all the electricity, or of a large portion of that contained in the storm cloud.

The slow and capricious travel of these fulminating balls is explained, like that of the globules of fire in the above-mentioned experiments, by the variations in resistance of the stratum of air that separates them from the earth, and by the natural tendency of the electric flux to seek the line of least resistance for its passage earthward.

As for the balls of fire that sometimes make their appearance amid the clouds themselves during violent storms, and of which Arago has related several examples, the experiment heretofore cited (Fig. 2) offers an exact although very reduced image of them, and it is only necessary to see it in order to understand the natural phenomenon.

In this way may be explained the different effects of ball lightning, that seemed to be an enigma as long as there was nothing to compare them with but the effects of apparatus producing static electricity, and in which the quantity of electricity in play is too small to present analogous phenomena, but effects which are, on the contrary, easy to understand when we compare them with those produced by a source of dynamic electricity in which quantity and tension are united.—*Comptes Rendus; La Nature.*

MESSRS. RENARD AND KREBS' ELECTRIC BALLOON.*

AN experiment in aerial navigation, crowned with complete success, has lately been performed at the military works of Chalais, and the object of the present note is to make known to the Academy the results obtained.

On the 9th of August, at 4 o'clock in the afternoon, a balloon of elongated form, provided with a screw and rudder, and having on board Captain Renard, the director of the establishment, and Captain Krebs, his colaborer for six years, made a free ascension. After a total trip of 4⅛ miles, effected in 23 minutes, the balloon landed at its starting point, after performing a series of maneuvers with a precision comparable to that of a screw ship evoluting in the water.

The solution of this problem, attempted as long ago as 1855 through the use of steam by Henry Giffard, in 1872 by Dupuy de Lome, who used manual power, and last year by Mr. Tissandier, who was the first to apply electricity to the propulsion of balloons, has, up to the present, been unsuccessful, since, in no case, has the balloon returned to its starting point.

We have been guided in our labors by the studies of Dupuy de Lome relative to the construction of his balloon of 1870–72, and, moreover, we have striven to fulfill the following conditions, to wit: stability, through the form of the balloon and arrangement of the rudder; diminution of the resistances to its travel, through a choice of dimensions; approximation of the centers of traction and resistance, in order to diminish the disturbing momentum of vertical stability; and the obtaining of a speed capable of resisting the winds that prevail three-quarters of the time in our country.

The execution of this programme and the studies that it necessitated were performed by us in common; still, it is well to point out the part that has more especially been taken by each of us in certain portions of the work.

The study of the peculiar arrangement of the suspension covering, the determination of the capacity of the balloon, the arrangements for securing longitudinal stability, the calculation of the dimensions to be given to the parts of the car, and finally, the invention and construction of a new pile of an exceptional power and lightness (one of the essential parts of the system), are the personal work of Captain Renard.

The divers details of constructing the balloon, the mode of uniting it with the covering, the system of constructing the screw and rudder, and the study of the electric motor, calculated according to a new method based upon preliminary experiments that permitted of determining all its elements for a given power, are the work of Captain Krebs, who, thanks to special arrangements, has succeeded in getting up a machine of unusual lightness.

The principal dimensions of the balloon are as follows: length, 165 feet; diameter, 27½ feet. The estimation of the work necessary to give the balloon a certain speed was made in two ways: (1) by starting from the data given by De Lome, and verified in his experiment of February, 1872; and (2) by applying the formula admitted in our navy in passing from a known ship to another of very slightly different model, and in admitting that the work in the two cases is proportional to the density of the two fluids.

The quantities indicated on following these two methods nearly accorded, and led to the conclusion that in order to obtain a velocity of 25 to 30 feet per second it would require an effective tractive work of 5 horses of 542 foot-pounds, or, on taking into account the duty of the machine and screw, a perceptibly double electric work measured at the terminals of the machine.

The motor was so constructed as to make it able to develop 8·5 H.P. on the shaft, representing 12 H.P. for the currents at the entrance terminals. It transmits its motion to the screw-shaft through the intermedium of a pinion that gears with a large wheel. The pile is divided into four sections that are capable of being grouped for surface or tension in three different ways

A few experiments were made for measuring the traction at the fixed point, and it was found to reach 132 lb. for a developed electric work of 1,848 lb. and 46 revolutions of the screw per minute.

* Note presented to the Academy of Sciences.

Two preliminary ascents, in which the balloon was balanced and held at 150 feet above ground, permitted its gyratory power to be ascertained. Finally, on the 9th of August, the weights lifted were the following (total ascensional force about 4,400 pounds):

Balloon	812 lb.
Suspension covering and cordage	280 "
Car complete	994 "
Rudder	100 "
Screw	90 "
Machine	215 "
Frame and gearing	100 "
Driving shaft	67 "
Pile and various apparatus	958 "
Aeronauts	304 "
Ballast	471 "
Total	4,391 "

At 4 o'clock in the afternoon, the air being nearly quiet, the balloon, being set free, and possessing a very small ascensional power, rose slowly to the level of the surrounding plateaus. The machine was set in motion, and, under its impulsion, the balloon soon quickened its pace, faithfully obeying the least indication of its rudder.

The first route taken was from north to south over the plateau from Chatillon to Vervieres. At the level of the route from Choisy to Versailles the direction was changed and the fore end was pointed toward Versailles, so that the balloon should not get entangled with the trees. Over Villacoublay, being about 2½ miles from Choisy, and entirely satisfied with the manner in which the balloon had behaved itself *en route*, we decided to retrace our steps and attempt to descend at Chalais, despite the small space free from trees. The balloon made its half turn to the right by a very slight angle (above 11°) given the rudder. The diameter of the circle described was about 984 feet. The dome of the Invalides, taken as a directing point, then left Chalais a little to the left of the route. Reaching the level of this point, the balloon changed its direction to the left with as much ease as it did before, and was soon hovering over its starting point at an altitude of 980 feet. Its tendency to descend at this moment was shown the more by a maneuver of the valve. During this time it became necessary to run backward and forward several times in order to bring the balloon over the point selected for landing. At a distance of 200 feet above ground, a rope thrown out from the balloon was seized by men, and the aerial ship was drawn down to the very field whence it had started.

Length of trip, measured on the ground	4·5 miles.
Duration of trip	23 minutes.
Mean speed per second	18 feet.
Number of elements used	32
Electric force expended at the terminals of the machine,	1,807·5 foot-pounds.
Probable duty of the machine	0·7
" " " screw	0·7
Total " about	½
Tractive work	880 foot-pounds.
Approximate resistance of the balloon	500 lb.

Several times during the trip, the balloon underwent oscillations of from 2° to 3° extent, analogous to the pitching of a ship, and which may be attributed either to irregularities in form or to local currents of air in a vertical direction.

This first trial will soon be followed by other experiments made with the machine complete, and which will permit us to hope for still more conclusive results.—*C. Renard and A. Krebs, La Nature.*

[See engravings in SUPPLEMENT, No. 457.]

AUTOMATIC FREIGHT CAR COUPLERS.

THE accompanying illustrations represent, with two exceptions, car couplers that were selected by the committee of the Master Car Builders' Association as being most suitable for adoption. This committee, at the annual convention held at Saratoga last June, recommended the following couplers as "worthy of special mention":

Archer, Cowell, United States, Janney, Ames, Mitchell, Wilson & Walker, Conway-Ball.

We regret that we have been unable to procure illustrations of the two latter in time for the present issue, but construction of the others is clearly shown in the accompanying illustrations.

The committee further state that they considered the following couplers to be "meritorious": Gifford, Granger, Bechard, Peace & Sankey, Hilliard, Hitchcock, Prescott, Marks, Howe, Union, Perry, and Burrill. We are enabled to illustrate two couplings in this category, the Gifford and the Union.

The committee which made the above selection was composed of Mr. J. W. Marden (Fitchburg), Mr. F. D Adams (Boston & Albany), and Mr. R. C. Blackall (Delaware & Hudson).

In 1882 a committee composed of Messrs. J. S. Lentz (Lehigh Valley), R. C. Blackall, Robert Miller (Michigan Central), and George Hackett (Central of New Jersey) also investigated the merits of car couplers and presented a report to an adjourned meeting of the Master Car Builders' Association. This committee reported:

"Of the many devices examined, we find several have special merit, and would recommend for trial:

"Under Class "A," S.B. Archer's,* G. H. Ames,* Perry's, Pugh & Browning's, and the Excelsior.

"Under Class "B," the Janney,* Hine's, and Davis'.

"As worthy of mention we would name Sanford's, Brook's, Hartwell's, Wilson's, Recht's, Cowell's,* Ennis', Sadler's, Hargrave's, and the Anchor."

It will be observed that less than two years afterward several of the above couplers had apparently fallen out of the ranks, for only those marked with a * are mentioned in any way by the later committee in 1884. Out of 18 couplers considered worthy of mention in October, but four survived the test of time, and were considered worthy of the same distinction in June, 1884. This certainly leads one to believe that the doctrine of the survival of the fittest applies even to such irrepressible organisms as car couplers.

At the discussion of this subject at the last convention of the Master Car Builders' Association, held at Saratoga, different members enumerated the following conditions which the best car coupler should fulfill:

1. Couple on a vertical plane, so as to allow for varying heights of draw-heads.
2. Dispense with loose link and pin.
3. Couple with ordinary link and pin coupler.
4. Cheap in first cost and repairs.
5. A valid patent, passed by Eastern and Western railroad associations.
6. Mechanically efficient.
7. Safe.

The following description and criticism of some of the couplers may possibly assist our readers in judging for themselves how far these conditions are fulfilled in the couplers now prominently before the car builders of the country.

The couplers illustrated may be divided into the following classes, according to the manner in which the coupling is effected:

Couple in a vertical plane	Cowell.
	Janney.
Fixed link and fixed pin	Ames.
	Mitchell.
	Wilson-Walker.
Loose link and fixed pin	Archer.
	Gifford.
	Union.
	United States.

The Cowell Coupling is very similar to the Janney. Both have a hook working horizontally, and therefore capable of engaging a similar hook on another car standing at a somewhat different level.

This coupling has not, we believe, been extensively used on freight cars, but has been applied to passenger cars on the New York Central, Flint & Pere Marquette, Cincinnati Southern, and some other lines.

The swiveling hook is kept in position by a small key. When it is desired to uncouple the cars, this key is drawn out by means of a car attached to a lever operated from the platform or side of the car. The hook is then free to open, and the cars can be pulled apart without further trouble.

It will be noticed that only the lever on one car need be used in uncoupling. In the Ames and Mitchell couplers of the fixed link class, the levers on both cars must be operated.

The draw-bar and most of the parts forming the buffer device are made of malleable iron. The head of the coupling is made preferably of wheel-iron with a chilled face. The wearing face of the draw-head measures 8 in. by 4 in. The upper right hand view shows the coupling as used with an ordinary link and pin.

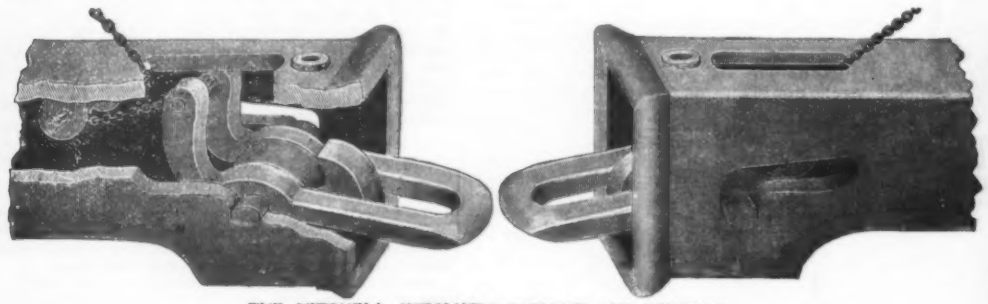
The Janney Coupler has been very largely used on the passenger equipment of the principal roads in the country, and is too well known to need description. The freight coupler, which is represented in the accompanying figures, is, as will be seen, similar in principle, but is of somewhat simpler construction. The principal feature of the coupler is the pivoted hook or knuckle, 2, which is retained in place by a key, 92, which takes the place of a coupling pin. When this coupling pin is withdrawn, the knuckle is free to swing on it pivot, and the cars are then uncoupled, and can be pulled apart.

In order to render it possible to couple with an ordinary link and pin draw-head, the end of the knuckle is provided with a hole through which the pin can be inserted, and the center of the knuckle is cut away to allow of the insertion of a link. It is obvious, however, that the coupling between a Janney and an ordinary link and pin draw-head is only possible when the heights of the two draw-heads are approximately equal, and that even in this case the coupling is not automatic. The coupling requires the use of a spare pin, and is also somewhat difficult to perform, as the link can only be inserted from one side, though on that side the brakeman can put it in position with more ease and safety than is the case with the majority of ordinary draw-heads.

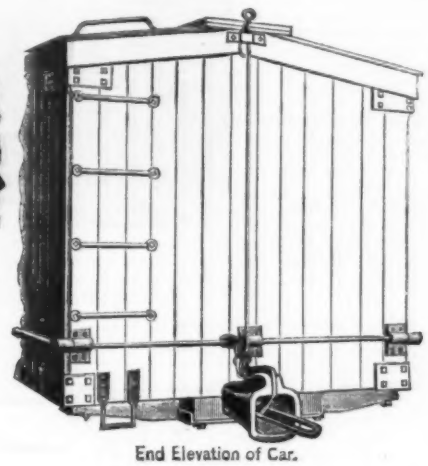
When a Janney draw-head buffs against any ordinary draw-head, the centers of the wearing faces of the two draw-heads do not coincide, the face of the Janney knuckle being almost wholly to the right of the center line. This might occasionally give rise to some inconvenience when cars were run together on a sharp curve.

The coupling-pin or key (92) is withdrawn, and the cars uncoupled, by means of the hand-lever 105. When it is desired to run two cars together without coupling, the pin is left in position, and as the knuckles are thus held immovable, the cars will not couple. When it is desired to couple, the coupling-pins are lifted and the knuckles opened. When the cars run together, the knuckles strike one another and assume the position shown in the plan, and the coupling-pin being dropped the cars are coupled. If the cars were run together so hard as to rebound before the pin can be dropped, the coupling cannot be effected unless the cars again strike one another. In any case the pin must be dropped by hand in order to effect the coupling. Thus the coupling of two cars fitted with the Janney can hardly be termed automatic, as the brakeman must place the knuckles in the proper position in order to commence the coupling, and move the coupling-pin lever in order to complete the coupling. It is to some extent a safety coupling, as he need not stand between the cars when they come together. A truly automatic safety coupling is one in which the cars can be coupled and uncoupled without any one going on the track or between the cars.

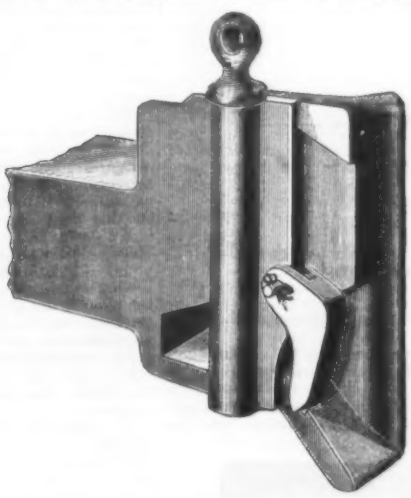
The Ames Coupler has a link of peculiar form having on



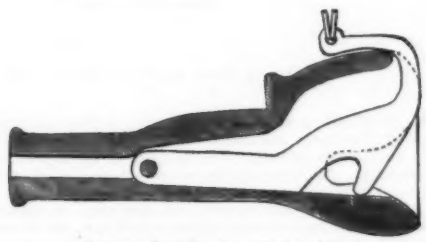
THE MITCHELL AUTOMATIC FREIGHT CAR COUPLER.



End Elevation of Car.

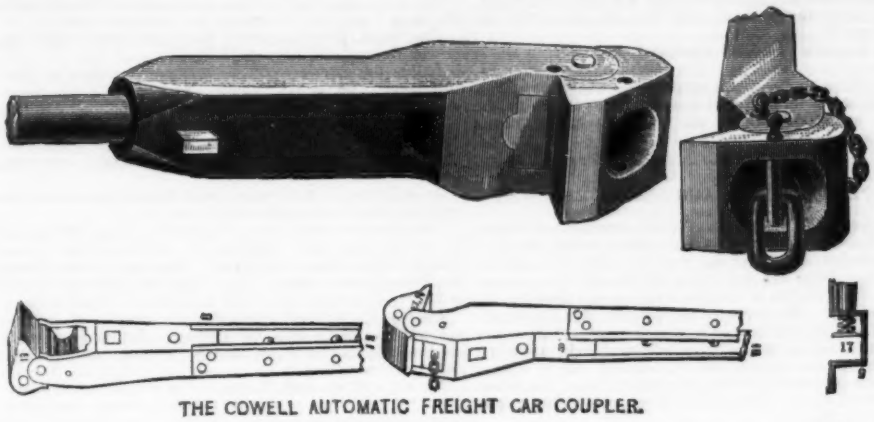


UNITED STATES AUTOMATIC CAR COUPLER.

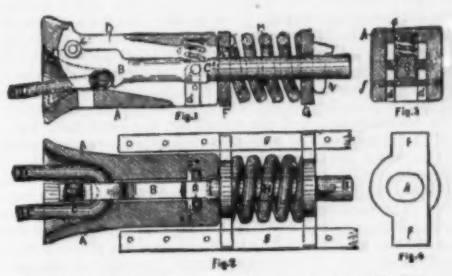


Longitudinal Section of Coupler.

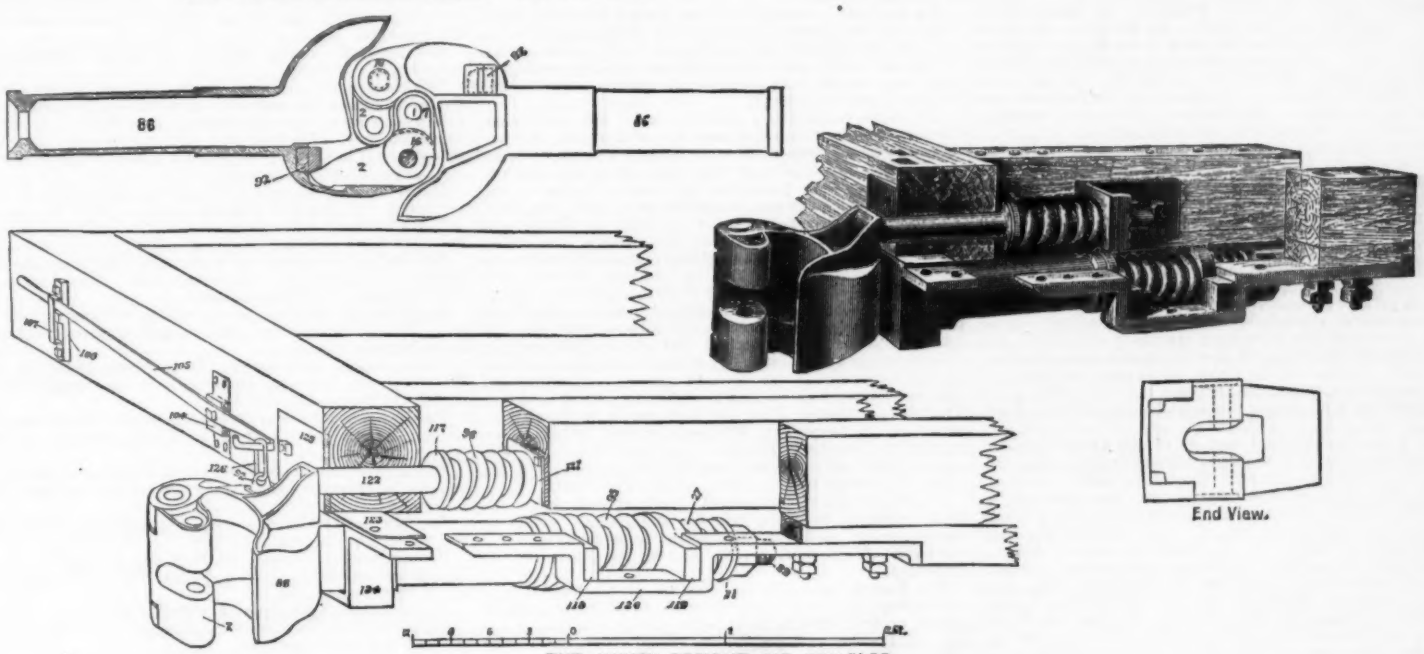
THE UNION AUTOMATIC FREIGHT CAR COUPLER.



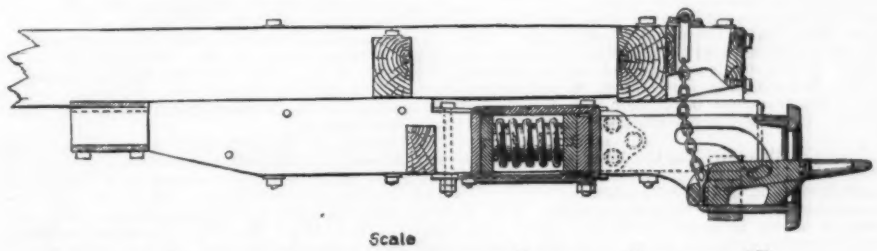
THE COWELL AUTOMATIC FREIGHT CAR COUPLER.



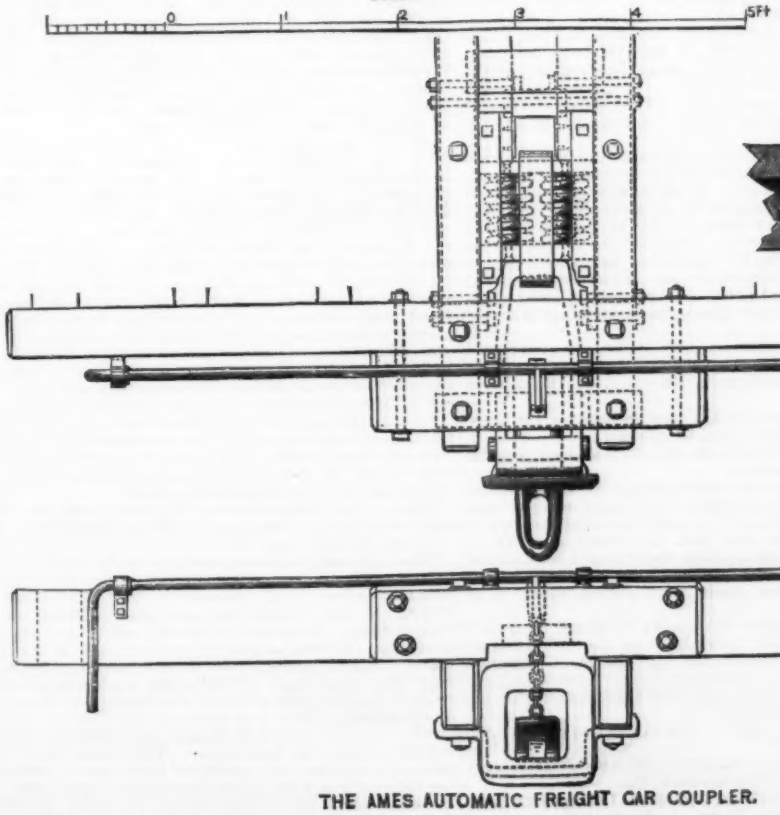
ARCHER AUTOMATIC FREIGHT CAR COUPLER.



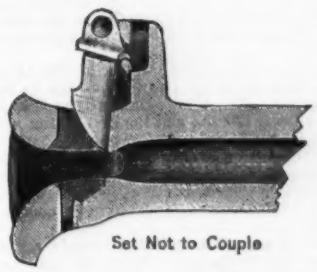
THE JANNEY FREIGHT CAR COUPLER.



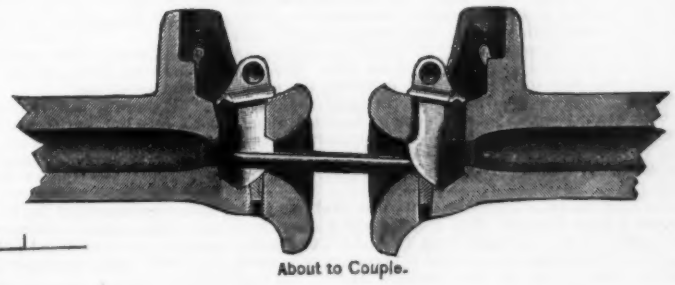
Scale



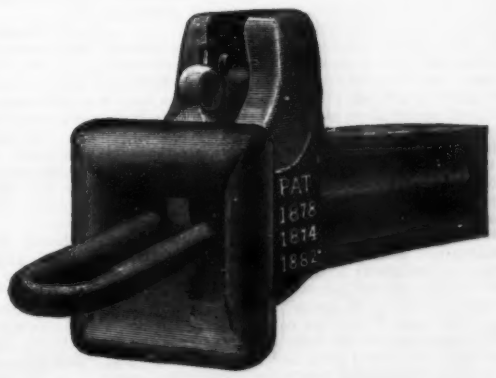
THE AMES AUTOMATIC FREIGHT CAR COUPLER.



Set Not to Couple



About to Couple.



THE GIFFORD AUTOMATC FREIGHT CAR COUPLER.

its lower side a sort of lug, which engages in the link of the adjoining car. This link has the advantage of being weighted at the rear end, and it therefore always stands level and approximately central in the draw-head, and does not need to be held up by hand in order to effect a coupling.

The link is stamped under the steam-hammer, and the oval section horizontal pin driven in tight after the link is placed in position in the draw-head. The draw-head is made of malleable iron, and is therefore light, and though somewhat expensive in first cost, would probably be more durable than most of the forms of cast-iron draw-bars.

The link will in the majority of cases couple automatically with an ordinary link and pin coupling, the brakeman having only to leave the pin askew in the hole of the ordinary draw-bar, when the concussion will shake it into position.

In coupling with a car also fitted with the Ames coupling, one link, no matter which, rides over the other, and the two engage. The cars can be uncoupled without going between them by lifting the rear ends of both links by means of the chains shown, which can be connected to cross shafts across the ends of the cars and operated from the sides of the cars in a manner easily understood.

This coupling has been extensively used on the Boston & Albany and the Lake Shore & Michigan Southern railroads, and it is understood that the management of the Vanderbilt roads contemplate adopting it for their whole freight equipment.

Mitchell's Coupler somewhat resembles the Ames. Both carry a link provided with a hook. In the Ames, this hook is on the under side of the link, and in the Mitchell it is on the upper side. In both cases the cross pin slides in a curved slot in the sides of the draw-bar, so that the link can slide back without being bent or broken, should it encounter an unyielding resistance. The link and hook are of wrought iron, and the draw-head is of malleable iron.

This coupling will also couple automatically with the majority of ordinary draw-heads, and can be uncoupled by lifting the rear end by means of the chain. Suitable holes in the draw-head render it possible to use an ordinary link and pin, if found desirable. It would appear that the attachment of the chain to the link is not quite so accessible as in the Ames, the top of the draw-head in the latter being completely open, as shown in the illustration.

The Archer and *Union Couplers* are somewhat alike, a sort of hook pivoted at the rear end of the draw-head and working in a vertical plane being used in both couplers. In the Archer, however, the draw-head is entirely relieved of any draught or pulling strain, all of which comes on the draw-bar and buffer spring. In the Union, as in most couplers, the draught strain is transmitted through the draw-head, as the hook works a pin passing through the sides of the draw-head.

Fig. 1 is a longitudinal section of the Archer coupler, showing the position of the parts when the cars are coupled. Fig. 2 is a horizontal section. The buffer-head, A, is of the usual pattern in its outward appearance. The draw-bar, B, has a hooked end, and is held in position by the lugs, *a*, which work up and down in grooves, *d*. Over the lugs is a small spiral spring, *c*, which, with the lugs and grooves, forms a toggle joint upon which the draw-bar oscillates independently of the buffer-head. The hook has an inclined face, so as to slide easily over the link in coupling, and on top is a lug to which a chain is attached through the opening, D, for raising the hook when uncoupling. Fig. 3 is a cross section, in which a rivet or bolt, *f*, is shown, holding the draw-bar in place. Fig. 4 is a front view of follower plate, F, containing an oblong slot, in which the draw-bar can move up or down in coupling or uncoupling. The uncoupling is done from the top or side of the car, a chain being attached to the pin, C, Fig. 1. Should the hook break, an ordinary pin can be inserted.

This coupling is in use on a large number of the cars of the Delaware & Hudson Canal Co., and it is said to have given great satisfaction. The total weight of the draw-bar and buffer-head is about 130 lb., and the cost of the apparatus is about $5 more than that of ordinary draw-bars.

The Gifford Coupler has been largely used on the New York, Lake Erie & Western Railroad, and is being applied to all the cars of that extensive system as fast as the present draw-heads need renewal. This coupler appears to be cheap, ingenious, and simple.

A flat, circular-faced annealed steel pin works in a slot in a bell-mouthed draw-bar or bumper. When the cars come together, the link enters the mouth of the draw-bar, and pushes the pin back and up an inclined plane until the bottom of the pin is so high that the link passes under it, and the pin falls from its own gravity through the opening in the link to its proper place in the draw-bar slot. When it is desired to run cars together without coupling, the pin is hung up clear of the link by means of the small projection at the back of the head, as shown in one of the illustrations. The pin cannot work out, but if broken a common pin can be used by removing a beveled plug in the draw-head, or a pin similar to the broken pin can be put in place in a few moments.

The inventor says in his circular that "the brakeman *has no business between the cars.* The coupler will work as well with him 50 ft. from it as right by it." And a little lower down, that "*it is automatic;* all that is necessary is to allow the cars to come together in the ordinary manner, the link in one draw-bar being held in proper position to strike the bell-mouth of the opposite bar." These two statements appear somewhat contradictory. The ordinary brakeman's arms are too short to enable him to stand 50 ft. away and hold up the link at the proper height.

The Union Car Coupler is so clearly shown in the illustrations that little description is necessary. We understand that this coupler has been on trial on the Eastern Railroad for some six months, and has proved so satisfactory that it has been adopted, and will be placed on all new cars built, and also on old cars as fast as new draw-bars are needed.

No trouble has been experienced with the coupling-hook so far, and there does not appear to be any liability of its jumping loose. It is considered that the danger from trains breaking apart is less with this device than with the ordinary link and pin; and there is no danger of the coupling-hook being damaged by striking the draw-head of another car. These, of course, are matters which can only be determined by long-continued practical trials on a large scale, but we must confess that the appearance of the coupling favors the idea that it might be liable to become uncoupled and be injured by the draw-head of another car.

The United States Coupler has been used on 40 cars on the Concord Railroad for over a year, and has, we understand, given great satisfaction, though it requires a somewhat longer link than usual.

The pin is made with a flange on the front side, which besides preventing its turning increases its strength. A dog is secured to this flange and serves to prevent the pin being detached from the draw-head, unless the dog is first purposely removed. When coupling automatically, the link enters the mouth of the draw-bar, pushes the dog, which raises the pin, which then drops through the link into its place, and the coupling is made.

The pins are made of steel, drop-forged, and the draw-heads of cast iron.

Pins with dogs complete are supplied at $1.50 each, and are guaranteed not to bend or break for 18 months. If the pin should break, an ordinary pin could be inserted in its place.—*Railroad Gazette.*

CAR COUPLERS ON MASSACHUSETTS RAILWAYS.

According to the provisions of a law enacted last winter, requiring Massachusetts railroads to adopt safety couplers on all new freight cars after this year, the railroad commissioners of that State devoted Sept. 25, 26, and 27 to a consideration of the claims of various styles of couplers for superior excellence. There were applications for the examination of 173 different couplers, which were called up in alphabetical order according to the names of their inventors, some of whom were represented by counsel. In so long a list of course only the merits and demerits of each can be but briefly touched upon in the following synopsis of the results of the examination:

Among those presented were the Archer (hook and link), which has been in all the tests, and is recommended by the National Car Builders' Association for further trial. It has been in use on 100 cars of the Delaware and Hudson for two years, also on the Lackawanna. It couples automatically with itself and all others.

The Ames coupler is a combination of link and hook, fixed, automatic with itself but not with others, and was represented as strong, durable, unfailing; it has been in use on 150 Boston and Albany cars four years, and about 50 Lake Shore cars six years; has not broken for two years; costs, all steel, $20 a car; malleable iron, $18; iron, $14. The patent has been passed upon by both the Eastern and Western Railroad Associations. Mr. Adams, the master car builder of the Boston and Albany, testified to its success, and in reply to a question by Chairman Russell, said he should prefer it to any other if all roads would adopt it.

The Best automatic has link and pin, couples with "anything or nothing," uncouples easily without much slack if desired, and never if not desired, and both the link and pin are adjustable by one lever and with use of only one hand. The promoter said it was open to only one objection, and that was a loose link, which is liable to get lost or stolen. The pin is protected from ice and gravel, and free from breakage. Total weight, 250 pounds; cost, $11.20 a car, exclusive of royalty. The pin is flat and broad. It is in use on 12 cars of the Denver and Rio Grande, where it has stood the severest possible tests. No cars are here.

The Barnes automatic couples by a hook underneath the head, movable from six different standpoints, works on shortest curves, and will uncouple at an angle when a car tips over. Eight pairs are in use on the Rochester and Pittsburg.

The Brown automatic has link and pin, and works in a double head (for high and low), inside of which is a simple device, costing only 15 cents, with gives the automatic action. Fifty cars equipped with it are in use on the Chesapeake and Ohio, and some on several other roads. The pin is fast, does not bend or break, and ordinary links are used. It will require new drawheads on most roads.

Byron's self-acting coupler is of the hook variety, somewhat like the Miller, but the hook has a deeper angle. The cars stand but 27 inches apart, while with others they are from 26 to 42. It will couple and uncouple on the shortest curve in use. It has been tried on one of 56 feet radius, and with both hooks drawn back there were 8 inches of space to spare. It will not couple automatically with other kinds.

The Beal coupler, link, and pin, the latter secure, works automatically with all, and is in successful use on the Florida Railway and Navigation Company's roads.

The Boston automatic comes from Minneapolis. It is of curved vertical hooks, automatic with each other only. Couples and uncouples easily; is strong, safe, and durable. It costs about $30 a car, exclusive of royalty.

The Charles C. Burton coupler, link, and fast pin, works automatically with all others, is operated from sides and top, and costs about a quarter more than ordinary draw-bars.

The Carman Ball coupler has a fixed ball on the end of the drawbar, which enters opposite drawhead. It has not been in actual use.

The Conway ball coupler has a loose ball in each drawhead, uses link but no pin, works automatically with others, and costs about $10 a car. It can be worked from side or top, but promoter said good railroad men object decidedly to working any coupler from the top of the car, as being hazardous and unnecessary. This coupler is one of the eight recommended by the master car builders for further test. It is in use on numerous roads. Two letters were read showing wherein it had failed, by the breaking of its working lever. Commissioner Kinsley remarked that it would have to be seen.

The Eureka coupler is automatic; is in use on the Grand Rapids and Indiana road on 400 cars, and has been for three years. Certificates from officers at the West were read.

W. L. Everett's coupler has been in use on the New Haven and Northampton road 18 months.

W. H. Flagg's attachment to the old fashioned pin and link coupler was explained.

Gifford's automatic coupler is in use on the Michigan and other railroads. It is a combination of a quarter circle and an inclined plane. Its cost in cast iron is $8 per car; in malleable, $13; and in steel, $16. It is used on 8,000 or 10,000 cars now in service, and is the standard draw bar of the Erie Railroad. That road has 2,000 cars with it attached. Several other roads were named where it is used.

Manly Howe's coupler was shown in model in a new form. It has been tried successfully on the Albany road in another form, of which the new one is an improvement.

The Hatfield coupler has been tested satisfactorily on the Boston and Maine Railroad.

W. S. Huntington's coupler is in use on two cars on the Erie Railroad.

A. B. Holme's coupler has been used with great success on coal cars running from Scranton, Pa.

The Hine coupler has been used on the Chicago and Rock Island Railroad, the New Haven and Northampton, and two other roads.

R. Hitchcock's coupler has been used nearly a year on the Connecticut River Railroad; costs $9 per car.

Hilliard's coupling is in use on the Grand Trunk road and the New York and Northern, and one other road.

Charles M. Hoag's coupler has been used to some extent on the Boston and Albany Railroad.

Hubbell & Co.'s coupler is a balance weight to hold the link level. No hooks, chains, bars, or rods are required, and it is improved by being made hard and smooth by use. It cannot be banged to pieces in 100 years. The St. Johnsbury and Champlain Railroad have used it 27 months, all the time, having but a scant number of freight cars on their road.

John Howe, Jr., showed a device for adjusting the ordinary coupler from the outside of the car.

The Janney coupler was explained at some length. It is in very general use. Among the roads having it are the Chicago, Burlington, and Quincy, the Chicago and Alton, and the Pennsylvania road. The latter has 3,500 cars equipped with it. Cars furnished with it cannot be telescoped.

Charles K. Cordrey presented the merits of his attachment for coupling and uncoupling. He had not made arrangements for exhibition on any railroad, nor is his apparatus in use on railroads.

W. Emmett showed his model for easy shackling and unshackling of trains, which he claimed greatly simplifies the work of the train men and reduces the danger. He had just got his patent, and had no car on a railroad in use with his apparatus.

Mrs. Susan P. Moulton showed a coupling of simple construction and low cost.

The Maulick coupler was shown. It is an attachment to the old-fashioned link and pin. It works with a spring, and is in use on a coal railroad running from Pittsburg, Penn., since February. The link and pin coupler, the exhibitor thought, will not go out of use for a long while, and this attachment makes it automatic.

Henry Mitchell showed a simple coupler, which is not yet in use. It costs $18 or $20 per car.

T. B. Nutting's coupler unshackles from the top of the car, and in case of accident will uncouple itself.

Simeon Nichols' apparatus works with a link and pin, and is easily manipulated from the top or side. It has been used on the Boston and Maine Railroad.

H. M. Sturgis' coupling is a coupling without a link or pin. It is of simple construction, and was patented last June, but is not yet in use.

Peck's coupler was shown. It has been tested on the Wheeling and Lorraine Railroad, and its superintendent certifies to the merit of the device.

The Marks coupler was explained, but the model was not shown. It is in use a year on the Cleveland road. A link is used, but not a pin.

The Loraine coupler was shown. It works automatically, and can be operated when there is a tension on the train. It is not yet in use.

The Leonard and Snow coupler was shown as very simple and at low cost, but not yet in use.

Powell's perfect coupler. It is in use on the Southern Kansas and on the Atchison and Santa Fe roads to some extent for six months past.

James Scofield's coupler was shown. The Texan Pacific road has had it in use five or six months. A certificate from the superintendent was read. The cost will not be more than $1 a car.

The Skinner car coupler works with a link and pin, and is a new adaptation of the old style coupler. It is of recent patent, and is not yet in use.

Turner's coupler works in with the regular system and couples with any other. It has a hook and lever. Its cost is 60 cents. It has been used hauling freight trains of 30 and 35 tons per car, running over Alleghany and Ozark Mountains. The St. Louis and San Francisco and Baltimore and Ohio use it.

It appeared in answer to questions put by S. W. Hatheway, attorney for the Boston Automatic Car Coupler Company, that the Hine coupler claimed to be almost identical with the Boston automatic car coupler, and that the Janney coupler claims to have originated whatever is good for anything in the Hine. The Hine is in use on the New York, New Haven, and Hartford and the New Haven and Northampton railroads and others. It seems that in the use of the Janney coupler it is necessary for a brakeman to go between the cars and throw out the loose pin, so as to leave it ready to couple, and that this is not so in the Boston automatic. All three of these couplers are automatic swing hooks, dispense with links and pins, and couple with old style, and all three are anxious for tests.

Among the other couplers explained were the United States and the Union, both in extensive and successful use in New England; the Smillie, link and pin, in use on the Lackawanna; the Robinson, link and hook pin, patented July 22, 1884; the Thomas Wood, of London, Eng., hook and link; the Williams, patented last April, to be tested on the Fitchburg; the Wilson & Walker, of Fitchburg, combined link and hook, much like the Ames, but will uncouple by raising either link; the P. Ware, link and pin, automatic with others, costs $6 a car, not yet in use; the James C. Bond, hook, automatic with itself, not yet in use; the Titus, hook like Miller, except that it swings, couples automatically with other hook designs except the Janney, and is in limited use on the Chesapeake and Ohio; the Colburn, which is an improvement on the Miller; the Vance, new and not in use; the Breyhan attachment, common link and fixed pin; the National link and pin; the Coombs, automatic, hook and link; the Prescott, in limited and successful use on Central Vermont; the Stebbins, hook and link, automatic with itself; and the M. Ross, opposite hooks, catching into draw-heads, and both to be lifted to uncouple.

Many of the devices were strikingly ingenious, and a few seem to have come very near perfection, and will bear close study and careful tests.

The commissioners accompanied by nearly the whole party of inventors and promoters and by a few practical railroad men made a tour of the railroad yards of Boston and vicinity. At East Boston they saw tested the Mark and the United States. Both scored successes, and elicited much admiration. Of course nearly all present were in a critical frame of mind, and some were not backward in pointing out what they considered defects. The Mark coupler failed twice in coupling with ordinary drawbars—once on account of a link being so bent that there was not room for the hook to enter, and the other time because the concussion displaced the raised pin in the opposite car. The United States failed two or three times—once when the force was so great that the car on which it was placed was thrown back, and once when a low link was propped up so as to strike the lifting device of the pin at its highest point. In the former case it was explained that the car should have had the brakes set,

or the approach should have been more gentle; in the latter it was claimed that the force was insufficient, as more is required when the link strikes the dog at the top. A train hand said that the failures were wholly exceptional. Some of the inventors, however, shook their heads, and said that the device required too nice an application of link and power; in other words, that it must be struck at just the right height and with neither too much nor too little force, or it would often fail. Aside from this it was generally admitted to be a good coupler. The promoters of it were quite annoyed by what they said was an unheard of slip in its working, and they will doubtless ask to have it observed in actual use.

In the Fitchburg yards tests were made of the Janney (hook), the Boston of Minnesota (hook), the Williams of Brattleboro, Vt. (hook with a second shoulder), the Robinson of Ohio (link and pin), the Smillie of Newark, N. J. (link and pin, both attached), and the Archer (hook and link). All worked well, and almost equally well, but the tests were few, and could have served only to impart a general idea of the devices in action. After the commissioners have seen all and brought their preferences down to a few, they will necessaril ysubject them to longer and severer tests, or, better still, take the testimony of the train men and yard masters who have worked and observed them under all the circumstances of ordinary use.

At the Lowell Railroad, half a dozen varieties of couplers were tested. All the tests were substantially alike, and consisted of pushing one car slowly against another, and at another time throwing one car swiftly against another. Efforts were thus made both to couple and to avoid coupling. The Ames automatic coupler of Canada was first tested. It consists of an inverted hook, which catches and holds the link automatically. This coupler worked well. The Byron coupler was not shown. It consists of a hook, which couples with the standard link. The Conway ball coupler, which has a loose ball in each drawhead, was the third one tested. It uses the link, but replaces the pin with the ball. It was one of eight recommended by a committee of the master car builders. The next shown was the Hubbell, which was a balance weight to hold the link level. The Union is too well known in this vicinity to need much description. It consists of a long latch fastened in the drawbar, which drops down of its own weight into the standard link. The Prescott is another invention using the link and hook. All the above worked satisfactorily in most of the tests to which they were subjected. The freight yard of the Boston and Maine was next visited, and tests made of the Holmes coupler, which uses a hook in place of the common pin. It worked well.

At the yard of the Boston and Providence road cars were examined which were equipped with the Cowell coupler. This is one of the eight recommended by a committee of the Master Car Builders' Association. It consists of a hook working horizontally, and does away entirely with the link and pin. It is similar to the Janney coupler, but has the advantage that it can be uncoupled from either car. The tests were eminently satisfactory, not a single failure being recorded. From this place the commissioners proceeded to the Boston and Albany's freight yard, west of Huntington avenue. The Ames coupler was first tested; it has a link of a peculiar form, the lower side having a "lug" or projection which enters the link of the next car; the link is weighted at the rear end, and is thus kept level. The Ames is another coupler recommended by the Master Car Builders' committee. The tests resulted very satisfactorily. Charles M. Hoag's coupler was next tested; it uses the standard link, and a double pin is the principal point of novelty. The Hitchcock coupler was the invention of the master car builder of the Connecticut River Railroad. It uses the standard link and a pin shaped somewhat like a half moon, which is worked up and down by a lever, though the pin works automatically by contact with another coupler. The Hein coupler has a horizontal hook, working automatically with one of its kind. Most of the tests of the above were satisfactory in their results.

The Old Colony freight yard in South Boston was next visited, and the Wilson automatic coupler, another of those recommended by the Master Car Builders, was first shown. It is very like the Ames coupler, but it was thought had some decided improvements, one being that it can be uncoupled from either car. The tests demonstrated that it is an excellent coupler, certainly equal to any shown during the week. The Davidson coupler, using the standard link in connection with a pin of a peculiar shape, was tested with satisfactory results.

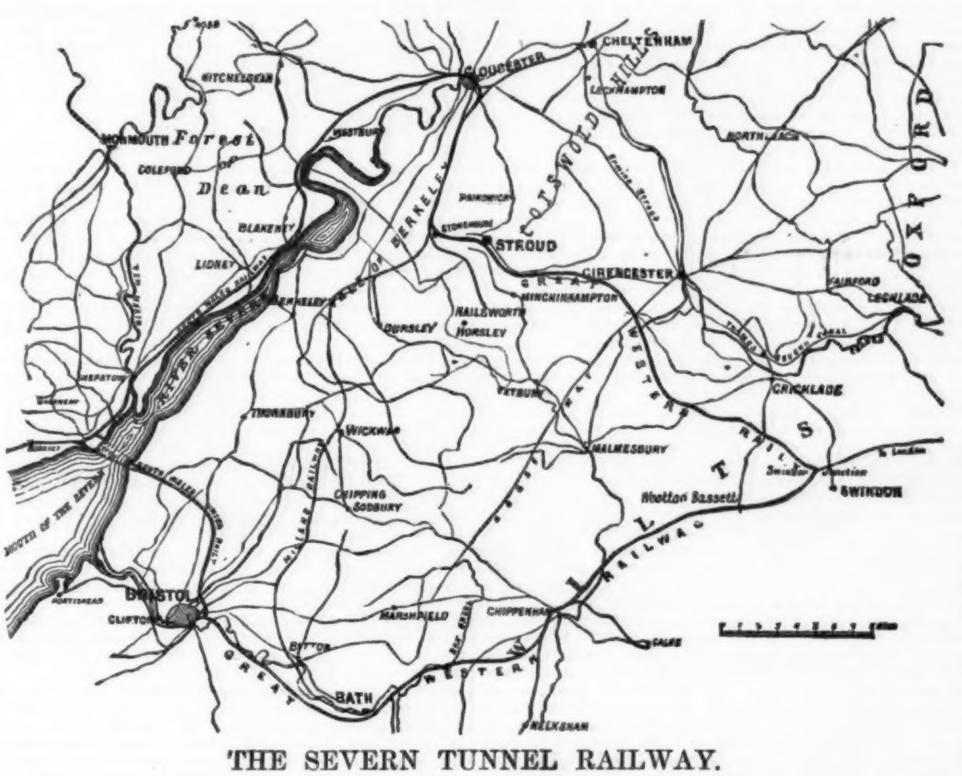
The freight yard of the New York and New England road, on South Boston flats, was the last place visited. Turner's coupler was tested on four cars of the Baltimore and Ohio railroad. It uses a link and vertical latch or pin, but, as a special link has to be used, it is scarcely probable that it will come into general use. One gentleman said that it was a step backward. The tests were only partially successful, and utterly failed when a standard link was used. Peck's coupler was next tested. It uses a pin and link, both fixed, and the tests were quite satisfactory. A coupler patented by Mrs. Susan P. Moulton was the last one tested. It consisted of a barbed tongue, the barbs on two couplers coming together, catching each other. It worked only partially successfully.

At all the tests a large number of gentlemen were present, and many brakemen watched them with special interest, expressing freely their views, which appeared most favorable to the most simple styles of couplers, and any coupler that used automatically the link and pin especially commended itself to them.

THE SEVERN TUNNEL RAILWAY.*

By J. CLARKE HAWKSHAW.

IN former days, before railways existed, one of the coach roads between England and South Wales crossed the Severn near the place where a railway tunnel is now being made. In those times travelers left their coaches on reaching the Severn at New Passage on one side and Portskewet on the other, and crossed the river or estuary, which is there about 2¼ miles wide, in open boats.



THE SEVERN TUNNEL RAILWAY.

Later on, lofty wooden piers were made on the banks of the Severn at the two places just named; on to these the trains now run, and passengers there leave them, and are taken across the river by steam ferry boats. The inconvenience of this journey is increased by the great rise of tide, amounting at springs to over 40 ft.

To do away with this break in the railway communication between the two parts of the country, plans were submitted to Parliament, one for the construction of a bridge, and the other of a tunnel.

In the year 1872 Parliament sanctioned the construction of a tunnel, and the work was begun in March, 1873, by the Great Western Railway Company. Shafts were sunk, and from them driftways were driven on the line of the tunnel. In this preliminary work no great difficulty was encountered, and the driftway under the river was nearly completed, only 130 yards remaining to be driven in order to effect a junction, when a large spring burst into the driftway driven landward from Sudbrook, and drowned the works under the river.

This happened on October 16, 1879; Sir John Hawkshaw, who had previously acted as consulting engineer, was appointed engineer-in-chief in conjunction with the engineer, Mr. Richardson, and a contract was made with Mr. T. A. Walker for the completion of the works. Considerable progress has been made with them during the last 4½ years, and the tunnel is now rapidly approaching completion.

Site of works.—The line selected for the tunnel is about half a mile south of the steam ferry between New Passage and Portskewet. The Severn is there about 2¼ miles wide, and is a tidal estuary rather than a river. Owing to the great rise of tide, the current is very rapid, reaching 10 to 11 knots in certain states of the tide. The bed, which is laid bare over two-thirds of the width of the estuary at low water, consists throughout of rock or shale. There are three depressions in it; the most considerable, called the "Shoots," is half a mile from the Welsh shore and has a width of 550 yards and a depth of 60 ft. at low water and 96 ft. to 100 ft. at high water.

Geology.—A section made on the line of the tunnel would disclose below recent surface deposits a series of trias marls and sandstones lying in nearly horizontal strata on highly inclined beds of coal measure, shales, and sandstones.

On the English shore a level tract of land extends for three miles from the margin of the Severn landward, terminating abruptly in an escarpment of trias resting on carboniferous limestone which is here brought up by a fault. This level tract lies 9 ft. below high-water mark of the Severn during exceptional spring tides, and would be subject to occasional overflows of tidal water if it were not protected by an artificial bank called the sea wall. This flat is covered by a bed of rich alluvium with some peat resting on sand and gravel which lies on the irregular surface of trias marl.

The rocks exposed over the bed of the Severn when the tide is low are trias, marls, and sandstones, and a conglomerate called the dolomitic, which is found forming a bed of varying thickness at the base of the trias. This bed, generally only a few feet thick, attracts attention on account of its characteristic appearance, being formed of large rounded pebbles and bowlders embedded in an equably hard matrix, the whole presenting much resistance to erosion, and being conspicuous when parts of the more yielding beds near it have been destroyed.

On the Welsh shore a low cliff of trias marl and sandstone rises about 30 ft. above high-water mark, and from thence to the western end of the tunnel this formation is found near the surface covered by some sand and gravel, and in one depression by alluvium, through which the marsh shaft was sunk.

From the western end of the tunnel an alluvial flat extends similar to that met at the eastern end.

The only other formation which need be mentioned is the carboniferous limestone which crops out at the surface at Portskewet Station and also in Portskewet village, 560 yards from the line of the tunnel. This limestone extends over a large tract of high land to the northwest; much of the drainage of limestone is, as is the case in most limestone districts, by underground conduits.

The tunnel itself passes for the greater part of its length through trias mostly in the form of nearly horizontal beds of marl, much jointed, the joints often open, and yielding in many places a great quantity of water near the eastern face; the upper part of the tunnel for a short distance is in the gravel overlying the marl, then wholly in marl passing below the coal measures are reached into a compact, fine grained sandstone. The passage from trias marls to the coal measures, which takes place at a distance of about a mile from the sea wall, is abrupt, owing to faulting. For the remaining distance under the river the rocks traversed consist of coal measure shales and sandstones, under the shoots; where the cover above the tunnel is only 45 ft. the sandstone is strong Pennant, much broken and jointed, though sometimes in massive beds; much water flowed from the open joints in this sandstone in many places.

The tunnel continues in the coal measures for a distance of about a quarter of a mile after reaching the Welsh shore, where they are found in the form of red shales and sandstones, generally very free from water. From these shales the tunnel passes gradually into the overlying conglomerate at the base of the trias. This was the most troublesome formation to tunnel through. At the middle shaft it is 26 ft. thick, full of open fissures discharging a great volume of water. From the conglomerate the tunnel again passes into the trias marls, and continues in them for the remaining distance to the western face.

Tunnel.—The total length of the tunnel when finished will be 7,664 yards (about 4⅓ miles); the length of the tunnel sanctioned by Parliament in 1872 was 4½ miles, but in 1883 an application, which was granted, was made to reduce the length by 13 chains by substituting that length of open cutting for tunnel at the Welsh end. This was done with a view to obtain material for making embankments for sidings at Rogiett Station, where the Tunnel Railway joins the South Wales line.

Another important alteration was made in the design after the works had made considerable progress. When Sir John Hawkshaw was appointed engineer in 1879, he recommended that the line of the tunnel should be lowered 15 ft. under the Severn in order to obtain more cover. The lowest part of the line was placed under the shoots, the deepest part of the estuary. The minimum cover then was 30 ft., which has been increased, by lowering the level 15 ft., to 45 ft. Under the shoots the line will be on the level for 12 chains. From this level piece the line rises with a gradient of 1 in 100 toward the English end and 1 in 90 toward the Welsh end. Originally the gradients were 1 in 100 each way. The gradient on the Welsh side was made steeper, in order to avoid

* Paper read before the British Association at Montreal.—*Engineering.*

SECTION OF THE SEVERN TUNNEL, SHOWING PRESENT CONDITION OF WORKS.

deepening the cutting at the Welsh end and so save excavation. As the heavier loads are mostly from Wales to England, this alteration of gradient will not be much felt in working the line; and as very little of the Welsh incline lies under the river, there is only a short length of tunnel under the Severn which will not be lowered the full 15 ft. The English incline has been lowered 15 ft. throughout. This alteration added about 430,000 cubic yards of excavation to the cutting at the English end.

Prior to this alteration a drainage driftway had been driven from the pumping shaft at Sudbrook to the lowest part of the tunnel heading under the shoots. A second heading has now been driven at a lower level to drain the tunnel as it is being constructed. This heading is circular, and 5 ft. in diameter inside the brickwork (13½ in. thick) with which it is lined throughout. Both these drainage headings are shown on the section. The tunnel is for a double line of way lined throughout with brickwork. The top is a semicircle of 13 ft. radius, with curved side walls and invert as shown in the transverse section.

Brickwork.—The transverse section of the tunnel shows the lining of brickwork to be 2 ft. 3 in. thick. This was the contract section, but under the shoots under the Salmon Pool, and in other parts where the nature of the ground rendered it advisable, the thickness was increased to 3 ft. in the arch and side walls. In a few places the invert was reduced to 1 ft. 10 in. and 1 ft. 6 in. in thickness. The bricks used are all vitrified. They are frequently tested with a hydraulic machine kept on the works for the purpose, and have borne from 25 tons to 70 tons without cracking, and as much as 77 tons before they were crushed; some came from Staffordshire, some from the neighborhood of Bristol, and from Catlybrook in Gloucestershire, near where the tunnel line joins the line from Bristol. They are all made from coal measure shales. As these shales are met with in the works, the contractor has erected crushing mills, drying sheds, and kilns, and makes 150,000 to 170,000 a week for use in the works.

The greatest amount of brickwork that has been done in one week is 2,000 cubic yards, requiring two-thirds of a million bricks. The brickwork is all set in mortar made of one part of Portland cement and two parts of sand. When much water was met with, it was led to pipes which are built into the brickwork. Some of these have been plugged up, but through many of these the water is still flowing. The largest pipe required for this purpose is 6 in. in diameter, from which a stream of water of the full section issued under considerable pressure at the time of high tides. Pipes could be only used when the water to be dealt with came in a definite stream from a fissure. In many cases in marl the water issued all over the section of the marl exposed in the excavation. It then became necessary to cover the whole surface with roofing felt in two thicknesses before any brickwork could be set. The time occupied in doing this, and in making other arrangements for keeping the water off the brickwork, more than trebled the total time which would have been required to finish a length of brickwork in a dry section of the tunnel.

Difficulties encountered.—Of the difficulties met with in carrying out the work, that of dealing with the water has so far been the greatest. Prior to 1879, when the large spring was tapped, the quantity was not great at Sudbrook; two 26 in. plunger pumps, one 18 in., and a 15 in. bucket pump were sufficient to drain the driftway 3,370 yards long under the river, and the driftway driven from the shaft inland, 355 yards in length. This landward driftway was in hard red shale interspersed with sandier rocky beds, nearly the whole of which was crushed and made into bricks used in the work. Very little water was met with in this driftway until on the 16th of October, 1879, the side burst in at a point 355 yards from the shaft, and a stream of water 7 ft. wide and more than 12 in. deep ran down the driftway (1 in 100), overmastered the pumps, and drowned the works under the river. After this occurrence the work was let to Mr. T. A. Walker, and attempts were at once made to check the flow of water.

Oak shields were lowered through the water, and were fixed by divers at the sides of the shaft over the openings to the tunnel driftways. These so far checked the flow of land water that the pumps were able to reduce its level to about 30 ft. from the bottom of the shaft, that is, below the level of the shields covering the openings to the driftways. To still further reduce the flow of water, an attempt was made by divers to shut a door across the driftway under the Severn about 330 yards from the bottom of the shaft, and thereby cut off the water flowing into the long driftway under the river. Divers in the ordinary dress failed to reach this door, but one named Lambert volunteered to go to it alone with Fleuss' apparatus. He succeeded in reaching the door and closing it, being under water without any communication with those above for an hour and 25 minutes. In the mean time a doorway was being built across the heading, down which the water was flowing, and as soon as it was completed the door in it was shut and the whole of the water from the spring was at once penned back in the heading behind it.

Soon after the outburst of this water into the driftway, springs and wells in the neighborhood for some miles round were dried, and the River Nedern, which at all times loses much water by fissures in the carboniferous limestone, which it passes over in the district adjoining the works, lost nearly all its water. When the flow down the driftway from the spring was stopped by the door being closed, the water soon resumed its former condition of level and flow in the wells, springs, and river affected by the outburst. No steps were taken to release the water penned back in the driftway till May 30, 1883, after a new pumping shaft had been sunk in which three new pumps were fixed at Sudbrook.

It was then found that a fall had occurred in the roof of the driftway behind the door, forming a cavity 40 ft. in height. The debris from the fall was removed, the pumps being quite able to deal with all the water from the spring, which amounted to 6,000 gallons a minute. The old driftway was cleared in the direction of the spring when it was known that another large fall in the roof had occurred.

A new working driftway on the level of the invert was driven below the old one. Very little water was met with in it until a point 97 yards beyond the door and 97 yards from where the first outburst of water in the driftway above occurred was reached. Here the water burst into the lower driftway suddenly from below, and in so much greater quantity that it filled up the works to within 95 ft. of high water level in 51 hours. At that level the pumps were able to hold it. It was estimated that during this time the inflow was at the rate of 27,000 gallons per minute. The pumps at Sudbrook, which could lift 11,000 gallons per minute, were kept steadily working for three weeks, and the level of the water in the shaft was gradually reduced, but latterly very slowly, not more than 7 in. in 24 hours. Each driftway had been provided with a door. That in the upper one was closed by the men before they left the work, but that in the lower driftway could not be closed, owing to the rush of water through it. This door was 150 yards from the shaft. Lambert, the diver, who had on a previous occasion closed a door under the Severn, was sent down to close this one; he succeeded in doing this in the ordinary diver's dress with the assistance of two other divers, one of whom remained at the shaft and the other half way between the shaft and door to help him with his air pipe.

On this door being closed the level of the water was rapidly reduced. As soon as the tunnel could be entered a headwall was begun 88 yards from the shaft, 15 ft. thick, and filling up the whole section of the tunnel. An iron door was fixed in it, and also two 12 in. pipes provided with sluice valves. The water is still penned back in the driftway behind this headwall. Three new pumps are being placed behind in one of the two winding shafts at Sudbrook, and when they are ready to work the total pumping power at Sudbrook will be about 27,000 gallons per minute, and it is believed that there will then be little difficulty in dealing with the large spring and completing the tunnel work past it. It is almost certain that the water tapped in the lower driftway came from the same source as that in the upper driftway, but being tapped at a lower level, a very large quantity of water above the normal flow at the higher level had to be dealt with which was previousiy stored up in the fissures of the limestone. It was the discharge of this stored water suddenly into the works that overpowered the pumps, and it is probable that steady pumping would in time have reduced the discharge into the lower driftway to near the amount that had formerly flowed into the upper one.

During the time that the works were flooded after the first eruption of water at Sudbrook in 1879, some falls must have occurred in the roof of the driftway below the salmon pool. Owing to the greater part of the debris from these falls having lodged on the timbering over the driftway, it was not suspected that cavities of any size were forming in the marl above. Considerable progress had been made with the finished brickwork from the sea wall shaft when an irruption of water took place (April 29, 1881) which mastered the pumps and drowned the works. On examining the bottom of the salmon pool over the place where the irruption of water occurred, a hole 16 ft. by 10 ft. was found in the marl. The sides, as far as could be ascertained by sounding, were overhanging, and the hole was full of large blocks of marl to within a few feet of the surface.

This hole was filled up with clay puddle and covered with a mound of clay puddle in bags. The pumps were then able to clear the works of water. As the driftways under the river were not joined at this time, the flooding was confined to the works in connection with the sea wall shaft on the English side.

Another fall was found in the roof of the driftway near this place, extending upward 23 feet to within 20 feet of the river bed. This cavity was carefully timbered as soon as it was found, and was built up with brickwork in cement as soon as a length of tunnel had been completed below it.

Much water was met with in the works under land to the west of Sudbrook. First in the dolomitic conglomerate overlying the coal measure shale and further west in the lower beds of the overlying marl, but no sudden irruption of water in quantity occurred, although owing to accidents to pumps the works from the two shafts westward of Sudbrook were on several occasions flooded.

The only really dry parts of the work were those in the fine grained trias sandstone under the river in some of the coal measure shales and in the higher beds of the trias marl and sandstone near the west end of the tunnel.

Excavation.—Some of the excavation for a short distance near the east end of the tunnel was in gravel. This owing to its loose and open nature required very heavy timbering. Almost the whole of the remainder, the exception being a short length of the softer coal measure shales, was in material so hard as to require blasting. Holes were drilled partly by hand and partly by machines worked by compressed air. When the Great Western Railway Company were carrying on the works themselves they used a machine made at their works at Swindon; and as a number of these were handed over to Mr. Walker when he took the contract, a great part of the work was done with them. They are very rapid in doing their work, but require constant repair. Several other drills were tried, the Darlington being most in favor, owing to its scarcely ever wanting repairs. Several sorts of explosives were used, but torrite principally, its fumes being found less noxious than those of dynamite. As much as 6,000 lb. have been sometimes used in one week. The greatest amount of excavation in tunneling done in any one week was 6,000 cubic yards.

The driftway, as originally driven were bottom driftways, but owing to the tunnel being made at a lower level than was originally intended, and the gradient altered, they became neither bottom nor top driftways in most places, and it was necessary to drive a new bottom driftway almost throughout the whole length of the work.

From the driftways breakups were made at intervals of about two to five chains. Some timbering was necessary in almost every length. In the gravel and shales this was of the heaviest description. Some of the Pennant, the dolomitic conglomerate, and some of the trias sandstone stood with little or none.

Four steam navvies are now at work in the cutting at the English end, which contained 790,000 cubic yards of excavation. This cutting is almost wholly in alluvium gravel and sand. The cutting at the Welsh end is partly in alluvium and partly in trias sandstone; it is now nearly completed.

Embankments are made along the sides of the cuttings throughout their lengths to protect the tunnel in the event of the low lands through which they pass being flooded.

Pumps.—On the following page is a complete list of the pumps used to drain the tunnel works, and the estimated amount of water which they will lift.

The total quantity of water now being pumped is about 19,000 gallons per minute. Four beat valves of gun-metal are used in all the large pumps, and they have been found to work very satisfactorily.

Shafts.—On the 4½ miles of tunnel there are shafts at seven points, viz., at each face and at five intermediate points. The greatest distance between any two shafts is 2 miles 25 chains, between the shafts at the sea wall and Sudbrook, which are separated by the Severn. The other shafts are from 25 to 40 chains apart at sea wall; and also at middle shaft there is in addition to the winding shaft a pumping shaft, and at Sudbrook there are now three pumping shafts and one winding shaft; one of these three pumping shafts was till lately used as a winding shaft. All the pumping shafts except the last mentioned are off the line of the tunnel, and connected with the works by culverts, which can be closed by sluices so that, in the event of a pump breaking down, the shaft can be kept dry by closing the sluice until the repairs are done. The following is a list of the tunnel shafts:

	Diameter, ft.	Depth, ft.
Green-lane winding and pumping	10	74
Sea wall, winding	18	96
" pumping	15	108
Sudbrook, winding	18	194
" winding now and for pumping	15	200
Sudbrook, pumping	18	204
" "	12	220
Middle shaft, winding	15	150
" " pumping	15	155
Marsh shaft, winding and pumping	15	105
Hill shaft, winding and pumping	15	86
West face, " "	10 by 18	71

The shafts were all lined with brickwork set in Portland cement mortar, excepting that at the west face, which was not lined, and one pumping shaft at Sudbrook intended to be a permanent pumping shaft, which is lined with cast-iron tubbing.

Driftways.—As has been already stated, the driftways originally driven were bottom driftways, but owing to the alteration in the level of the tunnel they ceased to be so before the enlargement, for the permanent work was begun under the salmon pool, and under the shoots the arch of the tunnel was turned without sidewalls from the existing driftway. It was, however, soon found necessary to drive a new one at invert level for drainage purposes throughout nearly the whole length of the work.

PARTICULARS OF PUMPS IN USE AT THE SEVERN TUNNEL.

Name of Pump or Locality.	Diameter of Working Barrel.	Stroke.	Gallons per Stroke.	Number of Strokes Allowable.	Gallons per Minute.	Total Gallons per Minute.
	in.	ft. in.				
Ableton Lane bucket	15 × 2	6 6	100	12	1,200	1,200
Sea wall plunger	15⅛ × 2	7 0	114	12	1,368	1,368
No. 1 bull plunger	26	10 0	231	12	2,772	
No. 2 "	26	10 0	231	12	2,772	
75 in. beam bucket	35	9 0	575	12	4,500	
70 " plunger	18 × 2	10 0	487	9	4,383	
70 " bucket	28	10 0				
New 70 in. beam plunger	30	10 0	518	12	6,216	
" " " bucket	35	9 0	375	12	4,500	
" 60 in. " "	31	9 0	295	12	3,540	
Total at Sudbrook	..	..	..	..	..	28,683
41 beam bucket and side pump	28	9 0	248	14	3,472	
Horizontal plungers and side pumps	18 × 2	8 0	193	10	1,930	
Old horizontal plunger	20	7 0	95	7½	712	
New 60 in. bucket	31	9 0	295	12	3,540	
Total at 5 m. 4 c. (middle shaft)	..	..	..	..	..	9,654
Marsh plungers	15 × 2	6 6	100	14	1,400	
22 bull "	15	7 0	54	12	648	
Compressed air engine	..	..	250	2½	625	
Total at marsh	..	..	..	..	..	2,673
Hill plungers	15 × 2	6 6	100	12	1,200	1,200
Cutting No. 2	15 × 2	7 0	108	12	1,296	1,296
					Total	46,074

N.B.—No deduction has been made from the above quantities for slip.

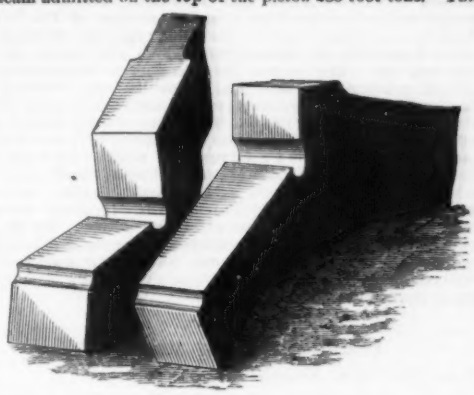
The driftways were from 7 ft to 9 ft. square. Timber was not required in them in the more compact beds of marl and sandstone and in the conglomerate.

Ventilation.—So long as the drift ways from the different shafts were in progress, ventilation was effected by the compressed air which was used for the rock drills, supplemented in one or two cases by pipes of larger diameter through which air was forced by blowers. After the driftways had been joined under the river a fan was provided at Sudbrook 18 ft. in diameter by 7 ft. wide, worked by an engine of 10 horse-power. This fan effectually ventilated the workings under the river. Electric light is largely used above ground and in these parts of the workings underground where the brick-work is completed. Lights of 2,000 candle power are suspended at intervals of about ten chains in the finished parts of the tunnel; much vitiation of the air is prevented by the use of these lights.

THE DARLINGTON FORGE.

AMONG the works visited by the Iron and Steel Institute during their Middlesbrough meeting last autumn, the Darlington Forge was by no means the least interesting. It covers 8 acres of ground, and employs from 400 to 500 men. The specialty is heavy forgings in iron and soft steel, chiefly for vessels and marine engines, but also for rolling mill and other stationary engines, the work being sent out machine finished when required. No less than 4,500 tons of forgings are turned out yearly for German, Dutch, and Danish ship-builders and engineers, as well as for the leading firms on the large rivers of the United Kingdom.

The Forge Department contains sixteen steam hammers, varying in weight from 20 cwt. to 13 tons, being capable of making any forging, from the smallest up to 40 tons, in a solid piece. The latest addition is a steam hammer, called "Tiny Tim," which is one ton heavier than the celebrated "Samson" hammer now working in Glasgow. The hammer-head, piston, and rod weigh together 13 tons, and the fall is 9 feet; so that the effective blow is 117 foot-tons, or with steam admitted on the top of the piston 233 foot-tons. This



hammer—shown by Fig. 1 of the accompanying illustrations—was made by Messrs. Glen & Ross, of the Greenhead Works, Glasgow. The standards are of cast iron, with end openings, as in the French hammers, for facility of working. The cross girder supporting the cylinder is built up of massive plates, strongly riveted; and the foundations, both of the standards and of the anvil block, consist of 18-inch balks of timber, all tied together. The hammer is served by two furnaces, and by two powerful plate iron cranes that lift up to 50 tons, all the motions being effected by steam power. During the Iron and Steel Institute's visit, the hammer was engaged on a crank shaft for the Clyde, to weigh about 17 tons when finished.

All the iron used is selected from locomotive scrap bought from the railway companies. It is freed from rust in revolving drums, piled, and rolled into bars, which are then cut into short lengths and cross piled to form the slabs and uses. In the case of crank shafts and the more important forgings, this method of dealing with the scrap iron is most essential, and produces a metal of great toughness and homogeneity.

A great many vessels are disabled owing to their stern frames giving way on account of their not being thoroughly and soundly welded up. To get over this difficulty, the company has erected and recently completed a smith's shop 250 feet long by 50 feet wide, wherein is erected a special steam hammer, designed and constructed at the works, which, as it is 30 feet in the clear between standards, is capable of taking in and welding up solid the largest stern frames made. The piston, rod, and head of this hammer—shown by Fig. 2 above—weigh 2 tons and fall through 4 feet, in ad-

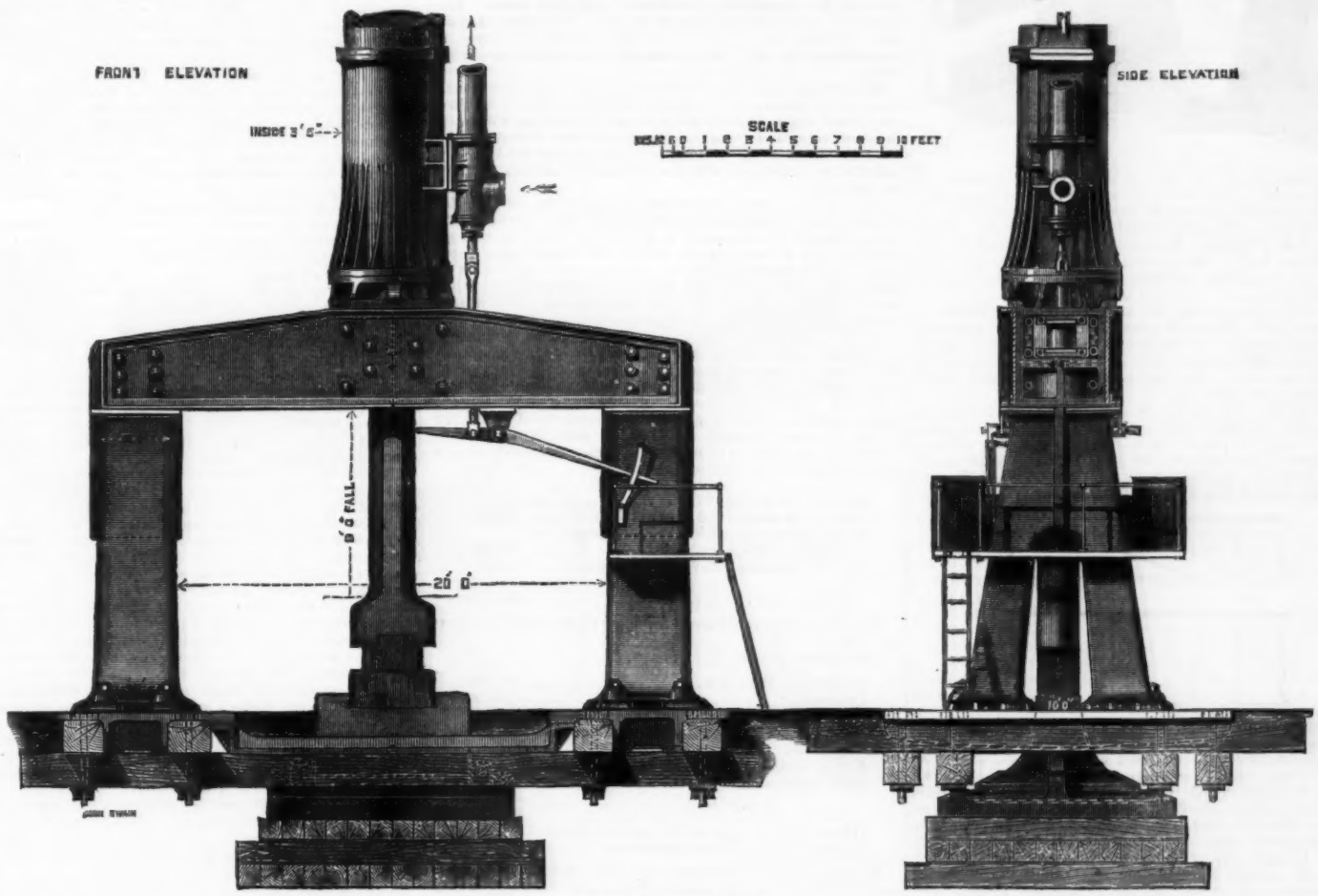


Fig. 1.—13-TON HAMMER.

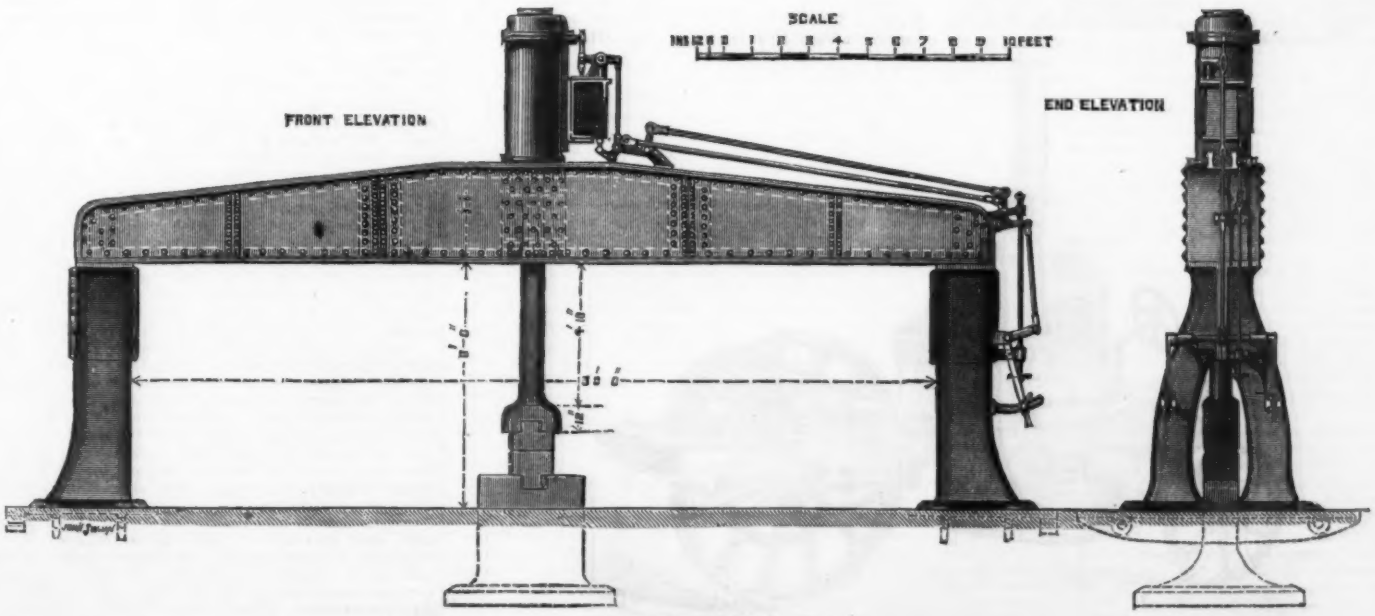
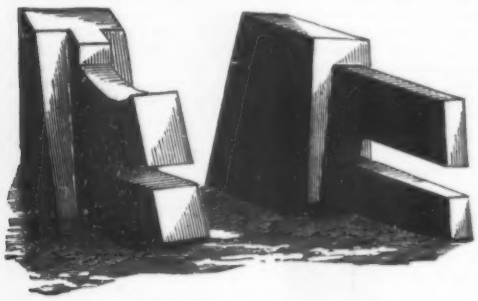


Fig. 2.—2-TON HAMMER

STEAM HAMMERS, DARLINGTON FORGE.

dition to which steam can be admitted on to the top of the piston, if necessary, to increase the force of the blow. Steam cranes by Davy Bros., of Sheffield, tested up to 30 tons, are erected, one on each side. Lloyd's visiting committee came to inspect this plant soon after it was got into working order. The members expressed their thorough approval, and permitted reference to them on the subject. In order to set at rest any doubt that might exist as to the soundness of welds made thus under the steam hammer, the company, at the request of Lloyd's surveyors, made a couple of forgings 15 inches by 7½ inches, and 12 inches by 6 inches, with welds in accordance with the annexed sketch, for the purpose of testing their soundness. On these forgings being bent and subsequently cut into by machine, as shown by the views on this and the preceding page, which have been prepared from photographs, they proved to be perfectly solid. This method of welding, which is a specialty with the company, is a great improvement on the old system of hand welding by smiths. The blast for urging the fires, when heating large ship forgings for welding, is afforded by one of Tannett, Walker & Co.'s 3-cylinder blowers, which give a steady pressure up to 3 pounds per square inch.

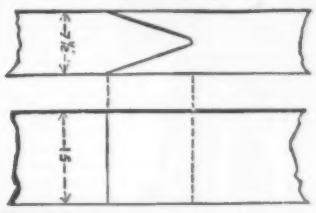
The machine shop connected with the Arlington Forge is



300 feet long by 75 feet wide. On one side is a gantry or gallery for carrying the smaller machines. Along the shop run four powerful overhead traveling cranes, worked by square shafting and capable of lifting up to 40 tons. Some fine lathes by Fairbairn, Kennedy, Smith, Beacock & Tannett, Scriven & Co., Berry, and other makers occupy one side, and a long line of slotting, planing, and drilling machines the other.

Gas, in this department, has been entirely superseded by the electric light. Four Siemens dynamo-electric machines generate the current for four lamps of 2,000 candle power each, while a fifth machine is held in reserve. They are all driven by one of the shop engines, to which a highly sensitive governor has been fitted.

In this shop a large portion of the tools are engaged in machining what in other establishments is usually smithed. For such work as stern frames, rudders, etc., this method affords much truer surfaces, and thus secures greater accuracy in working. A great many built-up crank shafts are now being turned out, one having been lately supplied for



the steamship Belgravia, of the Anchor Line of Atlantic steamers. The company also manufactures a large number of locomotive cranked axles and other forgings, as well as engine wheels, etc. There were recently in hand a number of 20-inch diameter screw shafts, and a three-throw crank shaft which weighs about 45 tons as turned and finished. The stern brackets were lately made here for the two twin screw gunboats built at Kiel by the Gebrüder Howaldt for the Chinese Government, the contract having been carried off against German houses through the character for superior work gained by the Darlington Forge. The stern brackets for the Livadia were also turned out at these works.

At the Tynemouth Exhibition, the Company showed some large forgings, and secured the first prize medal, together with a certificate of excellence in workmanship. The Company is "limited," the managing director being Mr. William Putnam.—*The Engineer.*

LIGHT TRACTION ENGINE.

Among special features of the late Royal Show at Shrewsbury was the small combined agricultural locomotive and traction engine of James Braby, of Rudgwick, Sussex. This engine is of 3 horse-power nominal, but is stated to be capable of indicating 7 horse-power. We illustrate this engine on the present page. It has double cylinders 4 inches diameter by 4 inches stroke, and is intended to run at 300 revolutions per minute, with a steam pressure of 120 lb. The boiler is a vertical one of the Field type, and is hung upon a framework of channel iron, which also carries the cylinders, etc. The power for traction is transmitted through gearing and chain gearing to the main driving wheel, which, by an ingenious arrangement, is also made to be the steering wheel. The weight, empty, is only 34 cwt. and taking this into consideration, the hauling of (on a fair road) from 4 to 5 tons is a good practical result. By a simple device the steering wheel is at once thrown out of gear, and the engine can be used as a stationary engine. It is built almost entirely of steel, thus securing lightness with strength, and is under the control of one person. By disconnecting the steerage and substituting a grooved driving wheel, it can be used as a locomotive on a single tram rail. This engine is also intended for use at military depots, mines, docks, and elsewhere.—*Iron.*

PURIFICATION OF WATER.

To the Editor of the Scientific American:

I notice in your issue of September 20, page 186, a statement of Mr. Gardner's (?) process of purifying water. The statement is mainly true, excepting this: "The cheapest method of filtration in the United States, so far as I know, is over three cents per 1,000 gallons, and this with irregular results."

The preparation used by Mr. Gardner is perchloride of iron, and it takes more than twice the quantity to coagulate impurities in the Mississippi River water, so they will settle in a reservoir, that we use in the same water in order to filter it by our process; besides, we have and use a still better and cheaper coagulant which costs but *three dollars per million gallons.*

The cost of a plant, according to our system, suitable for filtering the water of a large city is less than one-third the cost of reservoirs necessary to purify the water by settling with the aid of coagulants; besides, in many cases where there is no elevated ground for reservoirs, the water must be pumped twice if the settling method is used, making additional cost for pumps and their maintenance. This would be the case in St. Louis and New Orleans.

For every 10,000,000 gallons of water from the Mississippi River (this is about the present supply of New Orleans) there are 50 tons, at least, of mud, and the cost of carting or otherwise removing that amount per day would be quite an item.

In order to settle this quantity of water, at least three reservoirs would be required, each having a capacity of 10,000,000 gallons, the cost of which would be say $500,000.

The cost per annum of maintaining and operating such a settling plant would be about as follows:

Interest on plant @ 6%.....	$30,000
Cost of coagulants @ $10 per million gal....	36,500
Second pumping, with interest on plant, say @ $4 per million gallons....	14,600
Cost of removing silt @ 20 c. per ton.....	3,650
Total.....	$84,750

The cost of a *filtering plant* for same duty would be about $100,000.

Cost of maintenance as follows:

Interest on plant @ 6%.....	$6,000
Coagulants..... ..	10,950
Cost of pumping additional 5% of water used in washing filters (about $10 per million gallons).....	1,825
Cost of three men's labor @ $2 per day....	2,190
Sand replaced per year.....	500
Total.....	$21,465

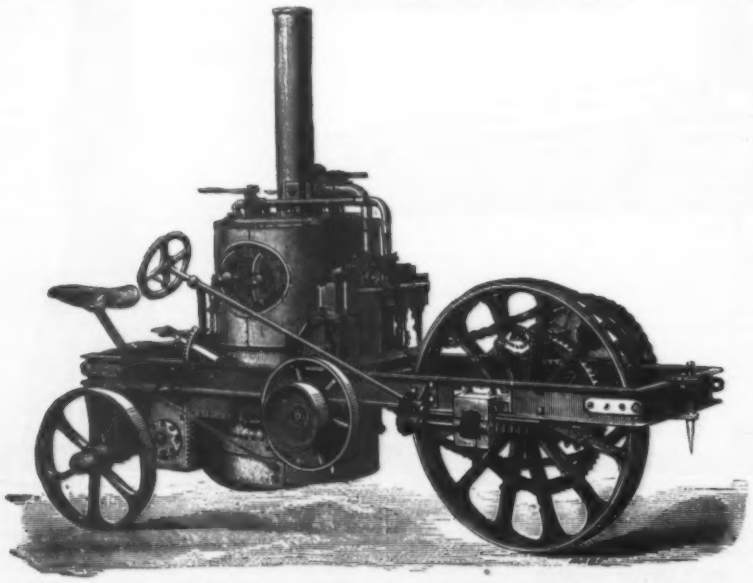
(The sediment removed in washing flowing back into the Mississippi River.)

We request the publication of the above comparative statement in justice to ourselves, and as a correction of the article in your journal referred to.

To verify our claims in this line, we have only to refer to the following of our customers:

Norfolk & New Brunswick Hosiery Co.....	New Brunswick, N. J.
McKean, Borie & Co.....	Philadelphia, Pa.
Louisiana Sugar Refining Co....	New Orleans, La.
Le Roy & Lamb.....	Cohoes, N. Y.
Star Knitting Co.....	" "
Troy Manufacturing Co.....	" "
Jno. Scott & Sons.....	" "
Stone, Blair & Co	Troy, N. Y.
Clark Thread Co.....	Newark, N. J.
Riverside Paper Co.....	Holyoke, Mass.
Decastro & Donner.....	Brooklyn, N. Y.
Harrison, Havemeyer & Co.....	Philadelphia, Pa.
Planters' Sugar Refining Co....	New Orleans, La.
Gibson House.....	Cincinnati, O.

J. W. Hyatt,
President the Newark Filtering Co.
Newark, N. J., Sept. 20, 1884.



LIGHT TRACTION ENGINE.

SCHWEINFURTH GREEN.

This color has been prepared by Russ & Sattler, of Schweinfurt, in the year of 1814; while others assert that Von Mitis of Vienna manufactured it at the commencement of this century. Shortly after its introduction various imitations were sold, as Original, Patent, New, Moss, Mountain, Cassel, and Paris green.

In the manufacture of Schweinfurth green, copper sulphate, or verdigris, is used. To a boiling solution of arsenious acid, verdigris, being suspended in water, is added. A brilliant green precipitate of copper arseno-acetate is thus formed. By using copper sulphate for verdigris the preparation is obtained by introduction of an acetate. According to a formula employed by Fuchs, of Schweinfurt, 25 kilos of copper sulphate and 5 kilos of caustic lime are dissolved in 6·1 liters strong vinegar; a boiling solution of 25 kilos white arsenic is then added. The contents of the vessel is stirred for some time, and left standing until the supernatant liquid is perfectly clear. It is siphoned off and used as solvent for arsenious acid; the pigment is washed, dried, pulverized, sifted, and lastly treated with salt water.

Schweinfurth green is superior as chromogene to other green colors, possessing brilliancy and rare luster; it is insoluble in water, and soluble in ammonium hydrate. Acid acetic and mineral acids decompose it, causing the precipitation of arsenious acid. It is used as color with both oil or water. When mixed with barium sulphate, gypsum, or lead sulphate, colors of a light green shade are formed; with chrome yellow it produces yellowish colors.

It has found by reason of its brilliancy and durability a wide and manifold application; being used as color for ball-dresses, artificial flowers, and wall-paper. It is the most poisonous of all copper colors, even when free of uncombined arsenious acid. The remark will not be amiss that arsenious acid produces toxical symptoms when applied externally, it being readily absorbed by the skin. Lebert says in his hand-book of practical medicine: "Though acute poisoning generally follows the internal use of arsenic, yet, by absorption from wounds or ulcers, when applied as a caustic arsenic paste, toxical symptoms are observed, which statement is also verified by Ambroise Pare, and *in extenso* treated in some new works on surgery. Arsenic has been detected in the urine a few hours after an external application of ½ square inch of arsenic paste.

The tendency of Schweinfurth green to disintegrate, when used as a paint, and becoming dispersed in the air, the absence of affinity to form a chemical combination with organic fiber, forbid its use in the manufacture of wall-paper. The moisture of the air or the dampness of walls causes the decomposition of this color, and formation of arseneted hydrogen, an exceedingly poisonous gas. When inhaled in minute quantities it causes headache, weakness, gripes, loss of voice, and nervous excitement, or when continually inhaled toxical symptoms of higher degree appear—the characteristic symptoms of blood-poisoning. By using Schweinfurth green as a coloration for artificial flowers or ball dresses, the consequences of its application become more serious. The increased motion and temperature favor a diffusion of the color into the air, while a copious perspiration of the body causes a generation of arsenic hydride.

The danger incurred by the use of Schweinfurth green is but lately known. Pappenheim has been the first who pointed with impartiality to the danger which the manufacture and use of arsenic colors involve; Stoeckhard, Chevalier, Bley, Ludwig, Draper, and Eulenberg have also written about the danger which this color is liable to produce. Of late there is a publication by E. Reichard, who states that the danger caused by Schweinfurth green does still exist when coated with water color or wall-paper.

Schweinfurth green has become substituted in the manufacture of cotton cloth by chrome green, Vert Guignet. At present poisonous pigment is only seen on artificial flowers, wall-paper, etc. The writer can testify by his own experience that in time past letter envelopes had an interior green coating which contained an arsenical color. It is a general rule that every green color possessing brilliancy and luster must be looked upon with suspicion. It would be unjust to eliminate from the series of colors Schweinfurth green as the only poisonous chromogene. Aniline colors which are brought into the market in large quantities show that cotton cloth often contains upon the square meter 2 grains of arsenic in form of aluminum arsenite, which is employed as mordant. The red and gray wall-paper and red-brown velvet paper demand our attention. It has also been observed that linings for hats dyed with coraline and woolen socks have caused an inflammation of and pustules upon the skin; which cause must be attributed to the presence of arsenic.

There are methods by which a layman can detect the presence of arsenic. The method of Marsh for the detection of arsenic, employed by chemists, demands great care and skill; a modification of the same has therefore been made. The material for examination, color or paper, is treated with muriatic acid, and then pure zinc is added; the liberated arsenic hydride is absorbed by a solution of silver nitrate.

A preliminary examination of some value is to ignite a part of the paper or cloth for examination, and then, after it has been burning for a very short while, to extinguish the flame. If arsenic be present, the glowing remainder emanates a garlic-like odor. The extinction of the flame causes the formation of a coal which reduces the arsenical compound, thus producing the penetrant, unmistakable garlic odor. The most simple and reliable method for the detection of arsenic in paper, wall-paper, cloth, and artificial flowers is described by Bettendorf.

Of the article for examination 2 or 3 square inches are used; they are cut over a sheet of white paper into small fragments, and are introduced into a small flask. A sufficient quantity of muriatic acid to cover the paper is added, and the flask heated over an alcohol flame until ebullition of the liquid commences. The solution is filtered, and a few crystals of tin bichloride are dissolved in the filtrate. When the filtered liquid is heated to its boiling point, it assumes a deep brownish tint and precipitates brown flakes; after a whi-

fine, dark-brown crystalline sediment of metallic arsenic is found upon the bottom of the flask. It is filtered, washed with distilled water, and dried. By throwing a few granules of it on a glowing charcoal, the characteristic garlic odor of arsenic appears.

Bettendorf's method can be executed within a short time, demands but a small quantity of material, and gives reliable and accurate results; it deserves a general application.—*Industrie Zeitung.*

ELECTRIC FISHES.*

Physiological Effects.—These have been known from all times. If we seize a living torpedo with the hands, we soon experience a strong shock, and the personal experiment that was made by Reaumur appeared amply sufficient to remove all the doubt about this that he held from reading the narratives of authors. The shocks experienced are comparable to those that are obtained from the Leyden jar or from piles, and if we persist in holding the animal in the hands we shall soon be forced to let it drop, provided it has a certain size and some strength. Moreover, it is not even necessary that the hands shall be in direct contact with the fish's body in order that the shock may be felt. Water being a good conductor, the action of an excited torpedo may be felt from a distance; and Matteucci relates that fishermen are made aware of the presence of these animals in their nets when, upon pouring pails of water into the latter to wash the fish therein, they experience shocks in their arms as long as the flow is continued. The physiological effects produced by the gymnotus are very powerful, and one cannot expose himself with impunity to the first shocks of a very large and strongly irritated animal. "If, by accident," says Humboldt, "a shock be received before the fish is wounded, or fatigued by a long chase, the pain and numbness are so violent that it is impossible to pronounce upon the nature of the feeling that is experienced. I do not remember of ever having received a more dreadful shock from a Leyden jar than the one I experienced upon imprudently placing my two feet upon a gymnotus that had just been taken out of the water." DuBois Reymond likewise experienced the effects of such a discharge one day, when, holding a gymnotus with rubber gloves, he let it fall in such a way that he was touched at the same time by both its head and tail. He tells us that he received a most formidable shock from the contact.

Chemical Effects.—The chemical effects produced by the discharge of electric fishes were ascertained for the first time by Davy, who succeeded in decomposing iodide of potassium thereby, and ascertained the parting of the iodine through the blue coloration that was assumed by starch mixed with a solution of the salt. These experiments were taken up and their results confirmed by Matteucci. On another hand, Davy and Faraday succeeded in electrolyzing water by means of these animals.

Physical Effects.—The production of sparks through the discharge from electric fishes is quite difficult to observe, and, as Reymond remarks, this fact is the more curious in that the electromotric power that resides in these animals is considerable. This observer finds a reason for this in the weakening of the currents produced in a general way in all animal electromotors through induction. However this may be, the spark has been obtained. Walsh asserts that he has seen it in the gymnotus, but Davy questions this, and attributes the light that he himself has seen in some of his experiments with torpedoes to the presence of phosphorescent animalcules that had remained sticking to the animal's skin.

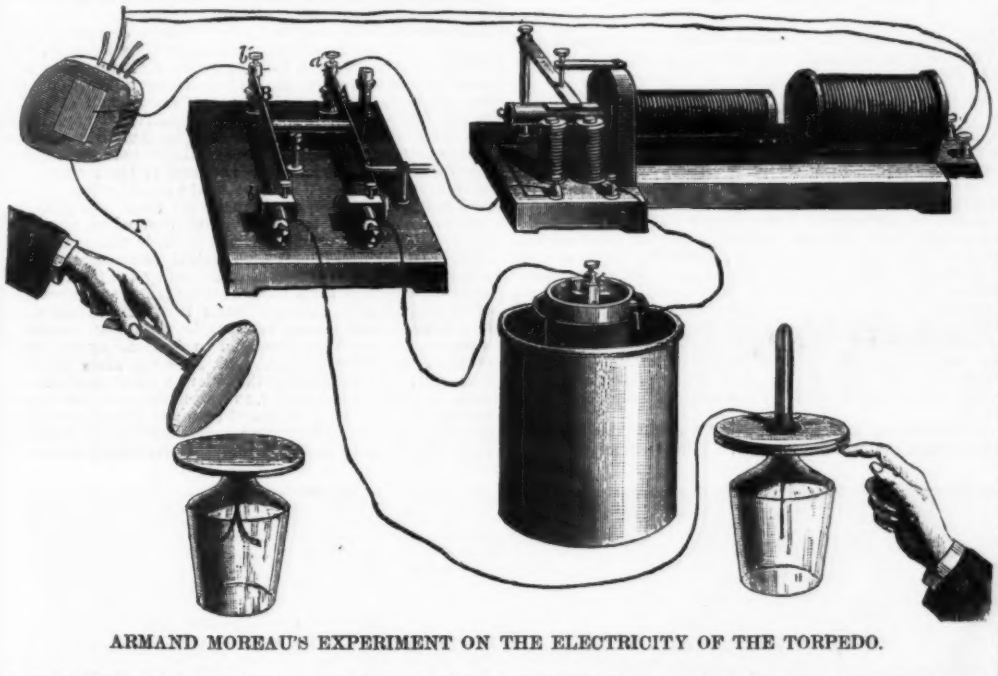
Matteucci, however, by means of an ingenius arrangement, succeeded in obtaining a spark at the moment of the discharge from a torpedo; and so did also DuBois Reymond. As for the thermic effects of the discharge from electric fishes, these have been demonstrated by Faraday, who experimented with a Harris electrometer upon a gymnotus that had reached London in a living state. This observer endeavored on the same occasion to establish a comparison between the shocks given by this fish and a battery of Leyden jars charged to a maximum. He found that the discharge from the animal was equal to that of a battery of fifteen jars of a coated superficies of 3,500 square inches.

Magnetic and Inductive Effects.—The discharge produced by electric fishes is capable of magnetizing a steel needle. This fact was established from the torpedo by Davy, and from the gymnotus by Faraday. In order to effect the magnetization it is only necessary to employ a solenoid. On another hand, induced currents have likewise been obtained by using the discharges produced by these fish as inductors.

Action upon the Magnetic Needle.—This action was observed for the first time in 1827 by Blainville and Florian de Bellevue at Rochelle, and afterward by Davy. If the two extremities of the platinum wires of a moderately sensitive galvanometer are placed in contact with the back and belly of a torpedo, and the animal is irritated, the needle of the instrument will be seen to be suddenly deflected at the moment of the discharge. Such experiments have been taken up by numerous observers, with the most improved galvanometers, and the action of the discharge upon the needle has been utilized for a profound study of the electric power of these fishes, and for ascertaining the character of the current produced.

In the majority of the experiments that have been here referred to, mention is made of the gymnotus and torpedo. The same results, however, have been obtained with the silurus, and, as regards the rays, it has been proved that their electric organ gives rise to discharges that are absolutely like those produced by other electric fishes. Prof. Robin, upon using a sensitive galvanometer and placing the platinum that terminated the rheophores upon the electric organ of one of these fishes, obtained considerable of a deflection of the needle. Upon placing galvanoscopic frogs upon the electric apparatus of the same animal, he obtained contractions in the frogs that always corresponded to the sudden deflections of the galvanometer needle. We dwell somewhat upon these experiments because they have definitely established the fact of the production of electricity by rays, although different experimenters who had failed in their attempts had been led to the conclusion that the organs of these fishes were only pseudo-electric ones. The cause of their want of success was due to their ignorance of the anatomical details of these organs, which, in the rays, are surrounded in all their one-third upper portion by the sacro-lumbar muscle; and it is owing to not having taken this peculiarity into account that these observers failed in their efforts.

In short, from what precedes we may observe the successive degrees through which our knowledge of the electric phenomena produced by the torpedo has passed. As Mr. Marey well says, "The progress of physics has gradually brought it into the domain of physiology." The invention of Walsh's tension electric machine has permitted us to demonstrate the nature of the discharge. The discovery of the Volta pile, of its electrolytic actions, of its influence upon the galvanometer, and of the spark which accompanies the breaking of its circuit, led to new researches, which showed that the same phenomena also occurred in the discharge of electric fishes.



ARMAND MOREAU'S EXPERIMENT ON THE ELECTRICITY OF THE TORPEDO.

Condensation of the Electricity produced by the Torpedo.—Through an ingenious arrangement, Armand Moreau has succeeded in collecting the electricity produced by the torpedo. The difficulty in the way of the experiment lay in the conductivity of the animal's humid tissues. Owing to this fact, the electricity, as soon as it is developed, returns by the same route that it came, an equilibrium is established in the animal's tissues, and it becomes impossible to lead it into a condenser. The problem to be solved, then, is to find a way of interrupting all communication between the fish and the condensing apparatus as soon as the discharge occurs. Moreau has succeeded in effecting this by an experiment that is worth dwelling upon. In the first place, he utilizes only discharges that are provoked in the torpedo, and not voluntary ones. The necessary excitation for producing these discharges is obtained by means of a current induced by one furnished by a Bunsen pile. The induced current passes into a circuit whose rheophores are firmly fixed to one of the nerves that has previously been isolated from the electric apparatus. The condensers utilized in the experiments were the gold-leaf condensing electroscope and the tin-foil condenser, which has the advantage over the Leyden jar of having 1,500 times more surface, a thin insolating foil, and consequently great condensing power. This condenser consists of two sheets of tin-foil about 5 inches in length by 0·8 meter in width. The lower one rests upon a sheet of gutta percha, and is separated from the upper by a strip of the same insulating substance. The four sheets thus arranged are wound around a stick. In order to collect the electricity from the torpedo, Moreau applied a small sheet of thin platinum, that had one of its edges wound around a copper wire, against the ventral and dorsal surfaces of the animal. When the gold-leaf condenser was used, one of these wires was put in communication with the earth. When the other condenser was employed, the two wires were connected with the tin-foil. The interrupter consisted of two parallel metallic rods connected by an insulating rod, and capable of describing simultaneously an arc of a circle around one of their extremities considered as a center. Motion was obtained by means of a spring, and occurred in a horizontal plane. In this travel one of the rods met a narrow metallic surface, which it passed beyond, and thus established for an instant a current from one of the poles of the Bunsen pile to one of the terminals of the induction apparatus in which the induced current was produced. At this moment, then, the excitation of the nerve of the electric organ occurred, since the induced current passed into a circuit ending there. But at the same time, the other rod, in its motion, met a plate some millimeters wider than the other one. Then, for an instant also, a route was established for the passage of the electricity from the organ of the torpedo to the condenser, and, as the plate last mentioned was wider than the other, this period was longer than that which allowed the exciting current to pass, and the excess of time allowed of the passage of the current from the torpedo.

Operation of the Electric Organs.—All authors agree that the discharges produced by electric fishes are entirely voluntary. They use them as a means of attack or defense, and it is easy to provoke them by the most varied excitations. In order to convince ourselves of the influence of the will in this action, it is only necessary to refer to the quotation that we have made from Humboldt. But it is interesting to remark at the same time that the faculty that these animals have of producing electricity seems to become exhausted by a too oft repeated exercise. If the discharges be obtained by excitations made in rapid succession, it is found that the intensity of the phenomena gradually diminishes, and that the discharges soon cease entirely. The animal becomes fatigued, and its electric organ is incapable of operating any longer. In researches upon the electric power of these fishes account should therefore be taken of this necessity of rest after preparatory manipulations, if it be desired to experiment under satisfactory conditions. When the animal is vigorous and has not been fatigued, it is capable of giving shocks, no matter what point of its surface be touched. Finally, we may add that the torpedo ceases to exhibit its electric properties when it is immersed in water at 0° or at 45°. In water at only 30° it soon dies, and its death is accompanied with a large number of violent discharges, thus proving that this temperature does not especially affect the electric organ.

Distribution of Electric Tension.—Since the invention of the galvanometer, it has been found that the current in electric fishes has a constant direction, and, whatever certain observers have thought of it, such direction cannot be changed at the animal's will. It has been found that in the torpedo the dorsal surface of the body corresponds to the + pole of the electric organ and the ventral to the — pole. Matteucci, in fact, has shown that on using a tolerably sensitive galvanometer the deflection of the needle proves that the current is directed in the instrument from the back to the belly of the fish. This experiment has been many times repeated, and its results have been confirmed by Moreau, among others, by means of the gold-leaf condensing electroscope. Moreau, on causing the ventral surface of a torpedo to communicate with the earth, and its dorsal with the upper disk of the apparatus, found that the gold-leaf became charged with negative electricity, thus proving that the dorsal surface had furnished positive electricity. (See engraving.)

From what we have said of the structure of the electric organs of the torpedo, the + pole, then, corresponds to the upper surfaces of the columns of which they are composed, and the — pole to their lower.

In the gymnotus and rays the same is not the case, seeing that the columns here are not vertical, but longitudinal, and in a direction parallel with the axis of the body, so in these fishes the positive pole is near the head and the negative near the tail.

If we enter still deeper into the study of the distribution of electricity in these animals, we shall find some very curious facts, that were first established by Colladon in 1881, and formulated by him as follows: In the torpedo (1) all points of the back are positive with respect to any point whatever of the belly; (2) two asymmetrical points of the back or two such points of the belly almost always give an appreciable current; and (3) finally, no current is obtained by a contact with two symmetrical points of the back or belly. Dubois Reymond gives the name of "Colladon currents" to those obtained between any two asymmetrical points of the back or belly. These currents are due to the fact that at these points the number of pile elements is not the same, because of the differences in the lengths of the columns there. So, although the polarity is the same on the same surface of the body, a current may nevertheless manifest itself through the sole fact of an irregularity in the electric tension at the different points of such surface. The intensity of the currents obtained upon touching the two surfaces of a torpedo reaches its maximum when the rheophores are applied to the thickest parts of the electric organs, that is, to the points nearest the median line. In the same way, the intensity of the current in the gymnoti, rays, and siluri is proportioned to the space comprised between the two points of contact. These phenomena may be explained by admitting that in proportion as the column is larger (the number of electric plates composing it being supposed constant for the unit of length) so much greater is the electromotive force. As the columns diminish in height in the torpedo from the median edge of the organ to the lateral parts, the electromotive force of the internal columns exceeds that of the lateral ones. The same explanation applies to the Colladon currents, which are always so directed that the + pole corresponds to the point nearest the internal edge of the electric organ. Dubois Reymond, however, does not think this theory sufficient to explain all the phenomena.

Relative Immunity of Electric Fishes with Respect to Their Own Discharge.—Electric fishes are traversed by their own discharge. There is nothing in this that should astonish us, and, moreover, it has been proved by the experiments of Boll and Reymond. Cavendish endeavored to represent the course taken by the electricity schematically. Reymond concludes that the strongest currents are those that flow through the brain and spinal marrow, since the internal edges of the organs are the most active.

In order to explain why, under such circumstances, electric fishes are not affected by their own discharge, we may suppose a less degree of sensitiveness, a tolerance of the nerves that has perhaps been brought about by a transmitted hereditary habit of enduring these discharges. It is certain, nevertheless, that the insensibility is not absolute. Dubois Reymond, in fact, has seen siluri assume, in an aquarium traversed by very intense currents, a constant direction such that the axis of the body was perpendicular to the action of current, and that the fish was traversed in the direction of its least thickness. On another hand, Moreau has found that in fatigued torpedoes pronounced motions of the eyes and fins may been seen in measure as the discharges are repeated.—*La Lumière Electrique.*

* Continued from page 7302.

ROOT FUSION.

SOME years ago "fusion" was accepted as the explanation of many peculiarities of structure, such as that of the gamo- or mono-petalous corolla. Most of these cases of so-called fusion are really not so. The parts are not separate at first and afterward fused, but merely imperfectly separated—separate above and not below. In the case figured, true fusion of the roots must have taken place at an early stage. The illustration is taken from a photograph obligingly forwarded to us by Professor Henriquez, of Coimbra, and represents the fused roots of Pinus Pinaster, discovered in a Portuguese forest, and now preserved in the museum at Coimbra. Cases occasionally occur where the annual rings of wood continue to be formed on the stump after the trunk has been felled. An instance of this was sent us by Mr. Webster, of Gordon Castle Gardens, some years ago, and of which an illustration was given at the time, showing that in all probability the new formations in the amputated stump owed their origin to inosculation of the roots, such as now represented.—*The Gardeners' Chronicle.*

THE NILE EXPEDITION.

GENERAL LORD WOLSELEY, who again takes immediate command of the British forces in Egypt, and who will personally command the expedition up the Nile, to Dongola and probably to Khartoum, for the relief of General Gordon and the military evacuation of the Soudan, is now in Egypt. The collection and advance of British troops, with a contingent of Egyptian troops, between Wady Halfa and Samneh or Sarras, above the Second Cataract in Nubia, more than two hundred miles from Assouan and seven hundred from Cairo, proceeds with great activity; while Major Kitchener is near Debbeh, or Old Dongola, three or four hundred miles farther to the south, watching the movements of the hostile Arabs, and arranging with the Mudir of Dongola, and with friendly Arab tribes, for their services in aid of the British expedition. It is understood that Lord Wolseley is not to seek hostilities with the partisans of the Mahdi, or with any of the tribes who have revolted against the late Egyptian rule of the Soudan, but will fight them if they attempt to dispute his passage or to prevent General Gordon coming to meet him.

The Nile has risen four feet at Wady Halfa, and seven steamers have passed the First Cataract. Two more companies of the 1st Battalion of the Sussex Regiment arrived at Wady Halfa last week. The battalion is under orders to push on to Dongola immediately, with three months' rations for 1,000 men. We refer to the map which we published last week, showing the whole course of the Nile from Assouan up to Khartoum, with the positions of Wady Halfa, Sarras and Samneh, New Dongola, Old Dongola, Debbeh, Ambikol, Abu Hameh, Berber, and Shendy, and the land route across the Bahiuda desert from Ambikol, avoiding the great northeastern bend of the river. The six principal cataracts or rapids, which are marked and named in our map, will probably be evaded by landing the boats and conveying them a few miles over short lines of temporary railway, for the construction and working of which several hundred skilled hands are to be sent out from England. The boats will be rowed, poled, sailed, or towed by large numbers of men, according to the condition of the stream and other circumstances; and Lord Wolseley's experience of such operations, in the Canadian Red River expedition of 1870, leads him to expect no great difficulty in this mode of proceeding. The chief anxiety is for the collection of sufficient stores of provisions, at those remote stations in the desert, to supply thousands of men, horses, and camels, when they arrive.

We have reason to believe that the following accurately represents the facts in regard to the Nile expedition: A force will be dispatched to the frontier of Egypt (Wady Halfa) with a view to being sent on to Dongola should the course of events render it necessary. Although the movement of mounted infantry and of some battalions of infantry up the Nile has already commenced, the strength and composition of the force will not be settled till Lord Wolseley has arrived in Egypt and consulted with Sir F. Stephenson. For the transport of the force 400 boats, 30 and 32 feet in length, and 6 to 7 feet beam, weighing from 950 to 1,100 lb. each, will arrive in Alexandria between Sept. 21 and 30. A further supply of 400 similar boats will follow at an early

ROOT FUSION: PINUS PINASTER.

date. Five hundred Canadian *voyageurs* will arrive at Alexandria at the beginning of October.—*Illustrated London News.*

THE NILE EXPEDITION.

THE following is a short outline of the plan proposed for a movement up the Nile Valley, and of the chief reasons which led to its adoption:

In the selection of the route by which a force operating for the relief of General Gordon should advance into the Soudan, the question of water supply held by far the most important place. Putting aside for a moment the consideration of the physical suffering produced by thirst, and the rapidity with which men in the tropical and semi-tropical regions are brought face to face with it, and applying to the question only the tests of weight and carriage, it was calculated that the carriage of water for one man for one day would require five times the amount of transport necessary for the conveyance of food per head for the same time, while the difficulties in the way of conveying and storing water are at least doubled by the nature of the burden carried.

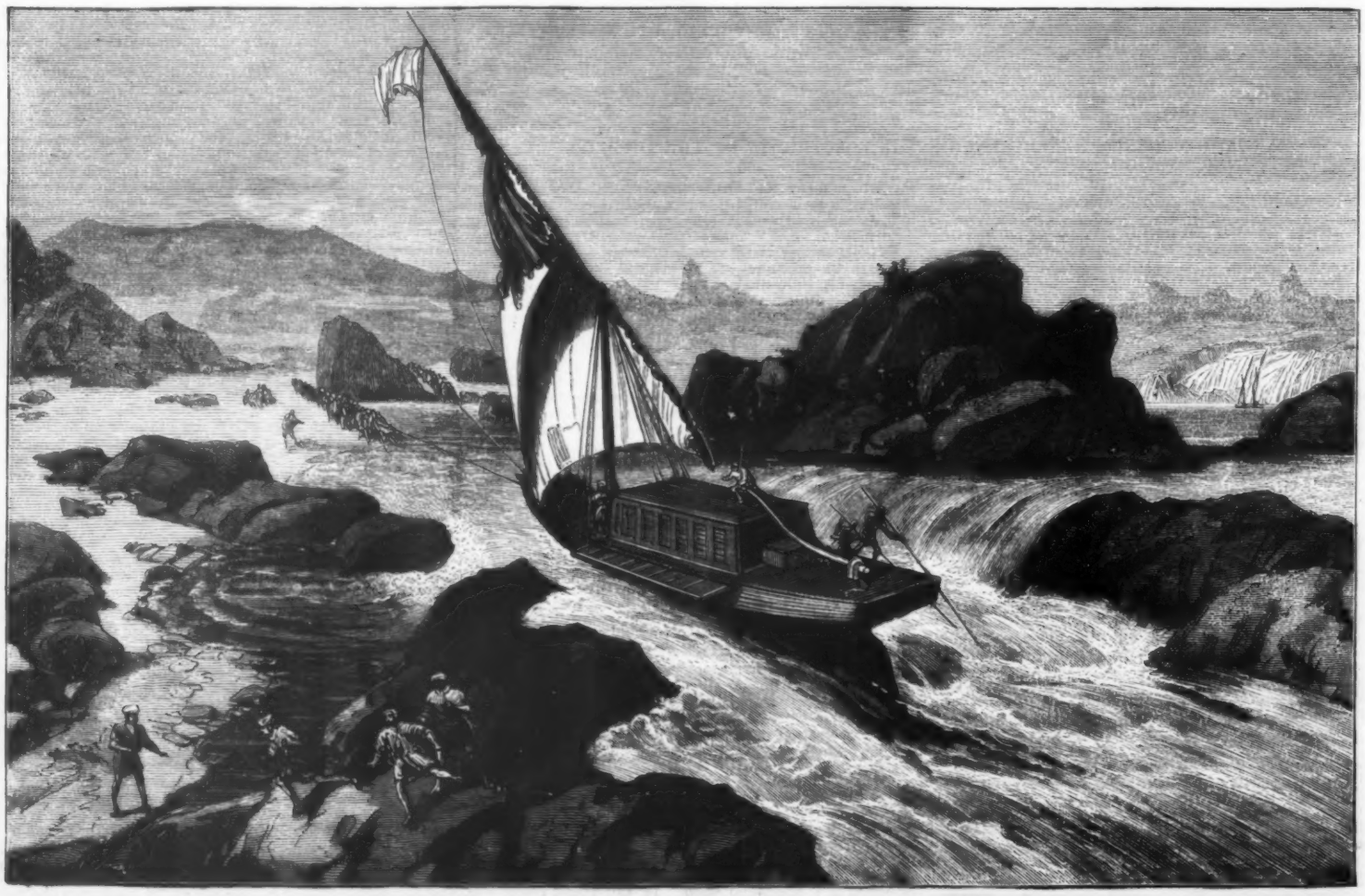
Alone among the routes proposed, the Nile was free from this paramount water difficulty. Whatever might be the length of its waterway or the obstacles that lay in its cataracts and rapids, the first and most important consideration—that of an inexhaustible supply of pure and wholesome water, in a land the climatic and physical conditions of which induced almost constant thirst—was met; and this advantage alone was considered so great that, if the cataracts had been much more difficult than they were known to be, the certainty of an inexhaustible supply of water through the Egyptian desert would have inclined the authorities to operate by the Nile route rather than to commit an army of English soldiers to the intense sufferings of a march across the practically waterless waste that for more than 200 miles lies between Suakim and Berber. But the difficulties which the Nile presented in its cataracts were not unknown in the history of the British army; they were almost identical, indeed, with physical obstacles which on another continent had been successfully surmounted by British troops.

Fourteen years ago a small expedition had followed a waterway in the depth of the North American wilderness, where there were rocks, rapids, cataracts, and waterfalls as formidable as those of the Nile.

The boats used in that expedition had been specially constructed for the work—quickly put together in different parts of Canada. They had been conveyed by steamer and railway many hundreds of miles before they could be placed upon the waters which they were finally to navigate. They carried ten men, with from two to three months' supplies. They were adapted for sailing, rowing, poling, and "tracking," and they were light enough to be lifted, in case of necessity, out of the water, and dragged or "portaged" along the shore.

In the 500 or 600 miles that lay between the height of land north of Lake Superior and the basin of Lake Winnipeg, which was the destination of the Red River expedition, there were nearly fifty interruptions from rapids and falls over which those boats had to be carried. Within the space of three months a battalion of infantry, with a small force of artillery and engineers, traversed the double journey, 1,200 miles in all, having in that time carried their boats, provisions, stores, and munitions, on ninety-four separate occasions, a total distance over rocks and through forest of fifteen miles. It was a military feat which attracted at the time less attention than it deserved, because the great struggle between France and Germany was then at its height.

In this Red River enterprise lay the germ of the expedition now proposed along the Nile. If boats of a certain description manned by soldiers had successfully ascended the Winnipeg River with its fall of two feet eight inches to the mile, why, it was asked, should not similar craft carry troops up the Nile, when the fall was not above one foot to the mile? There did not happen to be in Egypt any officer who, from personal experience with the American expedition, was in a position to explain to the authorities in Cairo the real nature of the craft proposed and of the methods of using them; and hence it was that the consideration of the Nile route was approached both by the naval and military authorities in Egypt from a point of view which regarded the employment of steamers of considerable size and native craft of from ten to twenty tons weight as necessary to the operation. But any expedition involving the use of large craft made high Nile an indispensable factor to the success of the undertaking, and high water in the Nile could only be depended upon during the months of August and September. For the work proposed to be done by the small boats of the American type, high Nile was altogether unnecessary; and so long as the river had twenty inches of water in its shallowest places, so long could these boats make good their way. These different points of view from which the question of the Nile route was regarded at home and in Egypt caused some loss of time in the preliminary stages of



THE CATARACT OF AMBIGOLE, ON THE NILE.

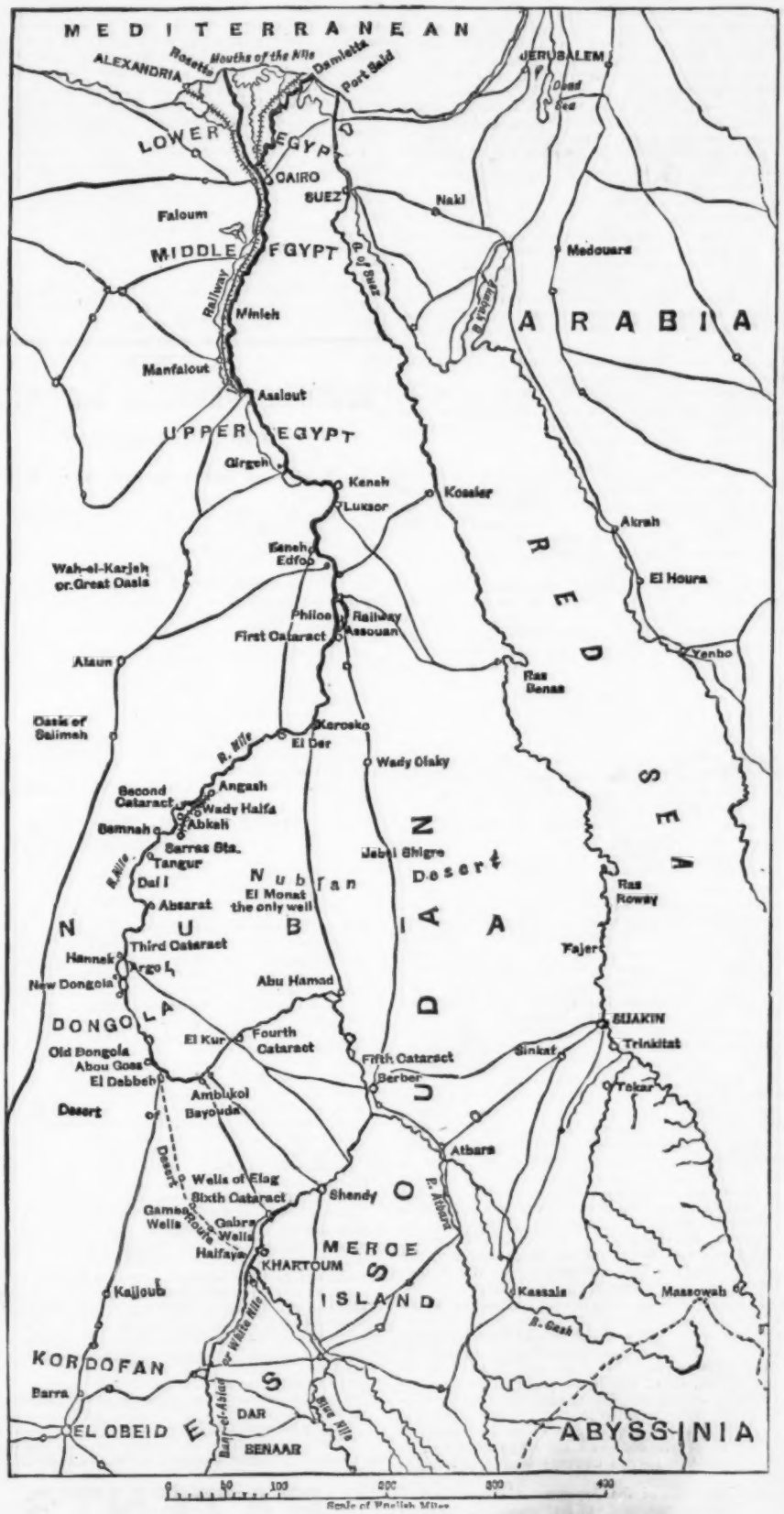
decision, and it was only in the middle of August that orders for the construction of the boats and the preparation of supplies could be given, and the work of organization could really begin.

Since then rapid progress has been made. On Monday last, sixteen days after the orders went out, some of the boats were already shipped for transport to Alexandria, and by the 15th of the month it is calculated that the entire consignment of 400 boats will be *en route* to Egypt.

Within the same dates nearly 3,000,000 lb. weight of stores and supplies will have been dispatched to Alexandria for the special use of the boat expedition. Toward the same port, in addition to these 400 boats and stores, another consignment of 400 boats, with a further supply of stores, will be forwarded between the 15th of September and the 1st of October, and by the last-named date some 400 or 500 Canadian voyageurs and 300 Kroomen from the West Coast of Africa will also be converging to aid the expedition with the distinctive skill in paddle and oar which long generations of work on dangerous waters have given to these widely differing races.

Meantime the days that must elapse before all can reach Alexandria are being utilized in the organization of the long line of railway and water communication from Alexandria to Wady Halfa, and further, to the final base at Sarras, on the river above the second cataract.

So far the original estimate of the time which these arrangements and preparations will involve, and of the date at which a start may be made from Sarras, seems to be possible of fulfillment, and the 1st of November promises to be the day by which the advance of the first boats from the second cataract toward Dongola can be made.—*London Times.*



THE NILE FROM KHARTOUM TO THE SEA.

ASTONISHING DISCOVERY.

DEIFIED MAYAS THAT LIVED IN AMERICA THOUSANDS OF YEARS AGO FOUND AMONG THE GODS AND GODDESSES OF JAPAN.

A FEW days ago we were invited by the learned Dr. Charles E. West, of Brooklyn, to examine his collection of Japanese antiquities, so rare and exquisitely beautiful, as works of art, that a volume of writing would hardly do them justice.

Prof. West informs us that "the collection was made by Charles L. Sanderson, Esq., of New York, who resided in Japan for nearly a quarter of a century During the war of 1868, between the Mikado and the Shogun, for the temporal power, which, for two centuries, had been usurped by the Shogun and his predecessors, who were nominally the Mikado's prime ministers, Mr. Sanderson furnished the Imperial army with the implements of war. And, when the long-lost liberties of the Mikado were restored by the overthrow of his enemy, such was his gratitude toward Mr. Sanderson for the service he had rendered, that he issued an order that, if Mr. Sanderson saw any work of art in temple or palace he might wish to possess, it must be given him. Without abusing this act of royal generosity, Mr. Sanderson took nothing from the temples the high priests were not willing to part with, and nothing for which he did not make compensation. From the Emperor's palace, several valuable articles were obtained, as the royal robes of the Emperor and Empress, a double shrine of great antiquity, etc., etc. From the oldest and largest temple in Japan, Nishi-Kong-Wanji, of Kioto, the most valuable part of the collection was obtained, such as shrines, bronzes of the gods, incense vases, candle holders, clocks, bells, gongs, communion vessels, flower vases of Satsuma, mirrors, the gold and silk robes of the priests, altar cloths, weapons of defense for the protection of the temple, etc., etc.

"It was the intention of Mr. Sanderson to settle in this country and build a house for his collection, but he changed his mind and disposed of his valuable treasures.

"It is very difficult now to obtain any precious works of ancient art from Japan. The Government saw that their art treasures were fast leaving the country, and appointed a commission to inspect all cargoes ready for shipping, and, if anything is found worthy to be retained, it is purchased* by the Government, and sent to the Royal Museum at Tokio.

"The arts of Japan show that a high civilization has existed among that remarkable people for centuries. Voluntarily excluding themselves from European associations, and western Asiatic as well, they have lived comparatively alone, having little intercourse with their more immediate neighbors, the Coreans and Chinese. It is a question of grave moment for them whether contact with our civilization is going to be of any benefit to them. It is very certain that these fine arts in lacquer, bronze, and pottery will suffer immensely in deterioration. This the Japanese themselves believe."

We had the gratification of passing several hours with Dr. West in his parlors, that are quite a temple of learning for an antiquarian. In every direction some fresh object of beauty meets the eye, that never tires of gazing at such gems of art, and as the owner of them gave us full permission to express all our ideas about them, the study was doubly enjoyable.

We had always believed that in Japan we should find traces of the Mayas. Long before Europeans ever approached the American continent, the country now called Yucatan had been invaded by various hordes and races less civilized than the Mayas, consequently even the so-called Indians of the Peninsula are of a very mixed race; but some are decidedly Japanese in appearance, so much so that when we first landed at Progreso we said, in stepping on to the wharf, "We are among Japanese." The history of the Japanese does not date back much more than 2,000 years, and it was somewhere about that period that many of the Mayas abandoned their mother-country, in consequence of the invasion of the barbarous Nauatts. There is no ancient history of Japan published, though the priests keep one locked up in their temples; perhaps some day it may be possible to get a look at it, if not obtain a copy—we will at least hope for such an event. But mean while we will gather all the knowledge we can from what is within our reach. Among Prof. West's collection there are nine or ten pieces of which we have made a special study, because they seem to be directly connected with the history of the Mayas. A few preliminary remarks will be necessary to elucidate the subject.

Many, many ages ago, Mayax (ancient name of Yucatan) was ruled over by King Can; it was at that period when the Mayas had reached the zenith of their civilization. King Can was married to Toz Chi † (cat mouth), and they had five children. The matrimony of Can and Toz Chi is represented on the front of an ancient palace containing ninety-nine rooms, the residence of the royal family, by two rattlesnakes entwining each other, their heads being crowned, and resting on the tail, above the rattles, a round urnlike ornament, with a bunch of feathers depending from it. These snakes are covered with feathers, but are not winged, the feathers merely indicating the feather robes worn on all state occasions by those of high rank. After a lapse of ages, the representation of the feathered rattlesnake—or king snake (ahaucan), as it is called in the Maya tongue—and the winged serpent were confounded one with another, so that it is sometimes difficult for the archæologist to decide whether the artist was portraying *Can* the king or *Can* the winged serpent, that, among some of the ancient Mayas, was typical of the spirit of the universe. The serpent was first used to delineate the outline or contour of what was then the Maya empire. It signified their country, and from that it grew to be an emblem of the whole world for them, of the universe in fact. As such, it was pictured by the most ancient artists, not with rattles, but a dart at the end of the tail, and the body not covered with feathers, but having wings, and here and there a single feather placed like fins. Some of the Indians in Yucatan even yet believe in a flying serpent with a dart at the end of its tail. They call it *Kanalcan* or *X-Kukulcan*, and never confound it with the rattlesnake.

The children of Can and Toz Chi were called *Can-Chi*, because it was the law that children should bear the united names of both parents. There were three sons, named respectively *Cay* (fish), *Aac* (turtle), and *Chaacmol* (spotted leopard). Their two sisters were called *Moo* (macaw, Ara militaris) and *Nicte* (flower). The surname Canchi, which name still exists in Yucatan, was added to each of these names. Cay, the oldest, became a pontiff. Aac was given to frivolous pleasures; and Chaacmol was a brave, ambitious warrior. The result of Aac's wasting his time in follies, instead of interesting himself in affairs of state, was that he suddenly found himself a nobody. Chaacmol, the youngest, who had no doubt maneuvered with great diplomacy, had all on his side—the power, the priesthood, the affection of the people, and the love of Moo, for whom Aac also entertained a violent passion, in consequence of which jealousy led him to many crimes. He killed Chaacmol and Moo, as well as the high-priest Cay, who had sanctioned their union; after which he for a time reigned supreme; but the downfall of the race dated from then, and was in the first place due to the evil deeds of Aac, who allowed himself to be carried away by his passions, and was finally put to death by his own people. The romantic history of this royal family was religiously handed from generation to generation, and its members, though by no means perfect models of virtue, were deified, and their history as gods and goddesses passed out of Yucatan to many countries; the events of their life seeming to be the origin of various stories, strangely similar, found in nations widely separated from each other.

We will now describe the Japanese objects of art and shrines that have most called our attention, and give our ideas concerning them, which the reader is at liberty to accept or reject as he thinks proper.

1. A bronze ornament of most perfect workmanship, representing a rock surrounded by the sea. On the rock

* Evidently the Japanese are more just and honest than the Mexicans, who likewise detain all objects of antiquity in their territory, but pay nothing to the person from whom they take them, no matter how much it has cost the discoverer to bring such objects to light.

† The *C* up side down, is a letter of the Maya alphabet, and sounds like *ds* in English.

stands a woman with a fruit in her right hand, which is raised; the fruit is round, and like a fruit called *canche*, that grows in Yucatan, on the shores of the sea and salt lagoons; the tree itself is also called *canche*. Several birds, that might well represent the ara, are graved on the woman's flowing garment; and at her feet is a dragon (winged serpent) that has the same three beard-like appendages on the lower jaw as we see in the winged serpent at Chichen. The rock surrounded by water suggests the peninsula Yucatan; the woman standing on it is perhaps a personification of the country of the Mayas. Maia being the name given to it by the Japanese themselves. Maia, among the Hindostanese, was the wife of Brahma—the feminine energy of Brahma—through which all things were created; Maya was therefore the mother of the gods, as she was called among the Greeks. These also called her *the good dame*, the daughter of Atlantis, that land in the midst of the ocean, surrounded by water, hence perhaps the rock on which the Japanese goddess stands. Atlantis is said by Plato (Timæus) to have been a most fertile land; the fruit, then, held aloft by the goddess if an emblem of fertility, would also be that of mother, which is the title of the goddess Maia in all countries where her name is found.

The figure, having birds on its dress, may also represent Moo, who was for some time Queen of Yucatan, and deified after her death. Remains of some of the temples built in her honor, in her own country, yet exist; and she seems to have become the Isis of the Egyptians, the good mother *Maut* worshiped throughout Egypt, the greatest deity, with her brother-husband Osiris, among the inhabitants of the valley of the Nile.

2. This piece (bronze) is from the temple called *Isen*, perhaps *Isin*, which means in Maya language "younger sister." It is a crane, standing on a large leaf with a bud between its beaks, and a large flower rising above the head, the stem being likewise in the beak. The bird and the flower may perhaps be typical of the sisters *Moo* (bird) and *Nicte* (flower), daughters of King *Can* (serpent or dragon); and these appear to be the same personages as Isis or Maut and Nike—daughters of Seb—among the Egyptians.

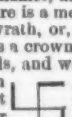
3. Double shrine from the Mikado's ancient palace at Kioto (old capital of Japan), afterward transferred to the palace at Tokio (present capital). It came from the Emperor, through his minister, and is the only shrine that ever left his palace. One side of this double shrine was opened once a week for the priests of the palace to worship. At the other side they might only worship once a year. The one opened every week has two large signs over the entrance, one of which seems intended for a flower. The other is a square with four openings in it. *Can* is likewise the Maya word for *square*, and also for *four;* while *chi* means mouth, hence opening. So if we translate these two signs to Maya language, they would mean *Nicte Canchi*. Nicte was of course the sister of Cay the priest, and we have reason to suppose that she herself was a priestess. The signs over the entrance of the shrine are thus:

(*Nicte.*)

(*Can-chi.*)

Literally, *flower-square with four openings.*

The central figure in the shrine appears to be a female, and has a flower in her hand, with a bird reposing on the stem. She is seated in a flower, and has a diadem of small heads, while from the top of her head the head and shoulders of a child rise up. Nicte Canchi, of Yucatan, had one child; flowers (the lotus) are painted over the floor and walls of the shrine. There is no evidence that the lotus was held sacred by the Egyptians,* much less that it was an object of worship, though it was thought to be an emblem of the god Nefer Atmu, and of the sun, but it was introduced in all subjects, particularly as an ornament. It would seem that in the course of ages the Egyptians had forgotten the real meaning of it, but might it not be a reminiscence of Nicte or Nike in Egypt?

On the left of the central figure is the god of fire, surrounded by flames, among which is the head of a bird. On the right there is a most furious-looking female, perhaps the goddess of wrath, or, judging by her hair, of fire; for headdress she has a crowned leopard head, and at the base of her seat are shells, and what appear to be cactus, with its fruit; also the sign  , equivalent to the Egyptian and ancient Greek *chi*. Three figures on the upper part of the shrine appear to be the same goddess *Nicte*, in different states. In all, her eyes are closed, which may indicate a deified human king; for the figures that represent some element or attribute have the eyes open. Deceased persons, portrayed in the ancient palaces of Yucatan, are nearly all with closed eyes.

Only a partition is between the back of this shrine and the one that was opened but once a year; perhaps because it was considered the most sacred.

Over the entrance this sign is twice repeated: seven feathers, just as Queen Moó wore during her life in Yucatan.

This shrine, like that of Nicte, represents a cave, and it is a noteworthy fact that Yucatan is undermined by extensive and numerous caves, large tracts of the surface of the land being a mere rocky crust. On the roof of the cave which the shrine represents, there is an elephant in a recumbent position. On its back stands the god of fire, and the bird's head is amid the flames that surround him. At the head and tail of the elephant are men—one holds a *lasso* and a *machete*. The husband of Moó became the god of fire. These two articles are both used by every Indian in Yucatan to day; the lasso to catch cattle, and the long knife called *machete* is their favorite weapon, besides serving them for agricultural purposes. The man at the head of the elephant has a bunch of seven feathers in one hand and a scroll in the other. Both the men's noses are like birds' beaks, and they have wings attached to their shoulders. On their breast are four (can) dots, forming a square.

Within the cave there is a small golden shrine, with a bird carved in wood over the door, and a small human figure made of gold inside. In front of the golden shrine are two winged, bird-beaked men; also ten others in the same guise, surrounding the miniature sanctuary, and all have *can* (four dots) on their breast. The central figure has teeth filed like a saw (this was fashionable among some of the ancient Mayas, as it is among the Fans of equatorial Africa, and some tribes of South America) and his fingers doubled up in a very peculiar manner, just as we see in certain sculptures at Yucatan, which had a meaning for the initiated. One man holds a sea shell. Another this symbol, made of gold —the sun. One is reading an open scroll. One holds a bell, and another, with square teeth, seems to be speaking. These figures grouped about the interior of the cave would be the followers or worshipers of Moó (bird) Canchi.

4. The great shrine from the temple of Nishi-Hong-Wanji, with the gods as they were placed on it. In niches beside the shrine were the fantail turtle, with a tail that is said to have taken 10,000 years to grow, the sacred dragon, and the Ho-wo, or Bird of Peace. This shrine, like every other, has a holy of holies, and round the roof are projections that curve upward, reminding us of the trunks of the mastodon faces that adorn all the ancient buildings in Yucatan. On the left of the sanctum sanctorum is a goddess seated on a throne formed like a flower, and at her back is a large gold plate covered with flowers. On the right we see the same figure standing in a flower. This goddess would again represent Nicte, who was always portrayed as a flower, and deified after her death. One figure on the shrine is a fat old man, seated with a fish under his arm, the head of the fish being exactly like the totem of Cay, a fish, found in the ancient sculptures of Yucatan.

The figures that were kept in niches near the shrine are particularly interesting. The fantail turtle with scales like those of a serpent on the front of the neck, and in the mouth teeth filed like a saw, though no turtle has teeth, is apparently a recollection of *Aac* (turtle). His totem was a turtle; and the family name *Can* (snake) may be indicated by the scales on the throat. But the most remarkable feature is the saw-like teeth, for the individual named Aac did actually have his teeth thus filed, in accordance with the fashion prevalent among those people at that time. Even the fantail, said to have taken 10,000 years to grow, is remarkable, for it is more or less that time since Aac lived.

The sacred dragon may be symbolical of King Can. In the right claw of the dragon is a gilded ball, and on the upper jaw are two horns. We have also found in an ancient mound at Chichen, Yucatan, serpents carved in stone with horns on the upper jaw.

The bird called *Ho-wo*, would be *Moó* (macaw), the beautiful daughter of King Can, sister of Cay, Aac, Chaacmol, and Nicte. As we have already said, she was represented by her totem, a macaw, and worshiped in many countries under various names. Chaacmol, her husband, wore three feathers, which might account for the three feathers in the tail of the *Ho-wo*.

Over the shrine hung a conical bell, most exquisitely chased, principally with an imitation of water, and the greque ornament, which in Egypt was emblematic of splendor, and is found on nearly all the ancient temples and palaces of Yucatan. The sea of water represented on the bell might indicate that the deities on the shrine came from over the water.

5. Bronze incense burner, said to be 2,100 years old; was used in the oldest and largest temple in Japan, Nishi-Hong-Wanji of Kioto, for 900 years, having been removed from a temple in the island of Satsuma. It was used for burning perfumed wood. The incense ashes were removed to other bronze vases, and kept till the vases were full, when they were transferred to a metallic chest, which was sealed and buried in the sands of the temple.

This burner represents a rock surrounded by water. On one side there are two fishes like carp swimming in the water; on the opposite side is a tree growing against the rock, and two deer. The fish are of exactly the same shape as a species called in the Maya language *Huun-cay*, which word means the *paper fish*, that may be interpreted as the *fish of books*, the wise fish. Cay, the pontiff, was *Huun-cay*, and represented by his totem the fish of that name. He was a wise and learned man, deified after death. The incense burner from Tokio would seem to be a reminiscence of him, for the books he used were made from the bark of a certain tree, and also of deer skin, the tree and the deer both being found on the burner. The rocks surrounded by water would indicate the birthplace of Cay (fish)—Mayax, the land of the gods. The deer even gives the name of the country, for Yucatan, up to the time of the Spanish conquest, was called "the land of the deer"—*ulumiteeh*.

The burner, then, seems to have been dedicated to Cay Canchi, who in many countries became the god of letters; Cay the fish—the *Oannes*—the being half man half fish who brought civilization to Mesopotamia; the Thoth or Hermes, culture hero of the Egyptians, who taught them the use of letters, and all other sciences; the Tien-hoang, to whom the Chinese attribute the origin of letters, and who is said to have given names to the ten *Kan* and the twelve *tchi*,* in order to determine the place of the year. *Kan*, say Yuen-leao-fan, signifies the trunk of a tree; and *tchi* are the branches. Cay was the Zamna of the Maya tradition, the Mayaoel of the Nauatls. The tree growing on the water's edge would be the *canche* that grows in Yucatan near the shores of the sea and salt lagoons, the sound fruit of which is likewise called *canche*.

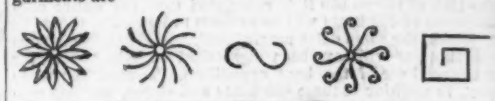
In *Cay* (fish), *Aac* (turtle), and *Coh*, or *Chaacmol* (leopard), the three sons of King *Can* (serpent, dragon), we see the three Hoangs—Tien-hoang, Ti-hoang, and Yiu-hoang—of the Chinese legend, all of which are represented with the body of a serpent or dragon. The dragon offers to the Chinese mind, as the snake does to that of the Egyptian, the highest idea of the creator that man can conceive—hence it is one of their finest symbols; and the Maya word *can* in all its other meanings always conveys the idea of might and power.

6. Sisi—the ideal lion of the Japanese—the guardian of the temple. These figures, made of Satsuma clay, are spotted precisely like a leopard, though there is no spotted leopard in Japan; and the right fore paw rests upon a small globe, signifying dominion. This would represent *Chaacmol* (spotted leopard), brother and husband of Moó. The totem of that powerful ruler was the leopard. Chaacmol was deified, and his history was the origin or many stories, that of Osiris being almost identical in some points with the facts that really transpired. Chaacmol, also called Cah and Balam, was killed by his brother Aac, which fact may have given rise to the tradition in Chaldea of Abal or *Abel* being killed by his brother, to that of *Bali* in Hindostan being killed by Rama in answer to the prayer of his brother Sougreva, and that of Osiris in Egypt being killed by his brother Set or Typhon; all for the same cause—jealousy.

In Mayax, Chaacmol became the god of fire, the volcanic activity that upheaves the lands from the bosom of the deep.

Cici in Maya means very good; when in composition, ciciol means pleasure, glory, peace, gladness.

7 and 8. God of the sea and god of the wind. On the belt of each of these we find the same leopard face as we see at the top and bottom of every antæ and pillar of Chaacmol's funereal chamber at Chichen. Ornaments prominent on the garments are



all emblems found in the edifices of Yucatan.

9 and 10. Candle holders, 1,800 years old, made for the great temple at Tokio, by Tozaya, a famous bronze worker. The candles burned in these holders, were made of a gum which came from the dragon tree. The holders represent the tree. They were used once a year, and were placed in front of the shrine. It is a belief that the disembodied spirits return once a year to visit their friends and former homes. Great preparations are made by the living for their spirit friends. They set lights upon their tombstones, and light the candles in the temple and their houses, that the spirits may find their way to and from the temple. This is a holiday season for the living, and is sacredly observed. The same feast to the dead is held in Yucatan, and in fact nearly all over the world. On the candle holders we again see the dragon with a dart on the tail and horns on the upper jaw.

Alice D. Le Plongeon.

Brooklyn, October, 1884.

* Wilkinson, "The Ancient Egyptians," vol. iii., pages 125, 263, 418.

* *Kan* and *tchi*, pronounced the same as *can* and *chi* in Maya.

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